L AND GAS URNAL

A Better Motor Fuel STARTS HERE

NATURAL GASOLINE
Propane
Iso-Butane
Butane
Iso-Pentane
Normal Pentane
Hexane
Heptane
Heavy Naphtha
STA-VOL-ENE

WARREN'S STABILIZED Natural Gasoline and STA-VOL-ENE

. . . or at any of WARREN'S many plants. When purchasing natural gasoline for blending, you want to be sure of its availability and quality. WARREN'S increased production, storage and shipping facilities insure you of a supply of Stabilized Natural Gasoline that consistently assures you of all the vital elements of today's modern motor fuel . . . High Octane Rating, Greater Volatility, Low Front End . . . those elements which insure Knockless, Quick-Starting, Carbon-Free motor fuel. Blend with WARREN'S Stabilized Natural Gasoline or Sta-Vol-Ene.

We manufacture special high octane blending agents which command higher prices but will help solve your octane problems.

WARREN PETROLEUM CORPORATION

Producers, Manufacturers, Exporters and Marketers

Export Terminals: Corpus Christi, Port Arthur, Baytown, Texas City, and Norsworthy, Houston, Texas.

TULSA 2, OKLAHOMA CABLE ADDRESSES: Stavolene, Warren

30 YEARS' SERVICE

Crude Oil, Natural Gasoline and Liquefied Petroleum Products

PRICE 50 CENTS TABLE OF CONTENTS PAGE 165 **MARCH 17, 1952**

ROCKWELL ORIFICE METERS

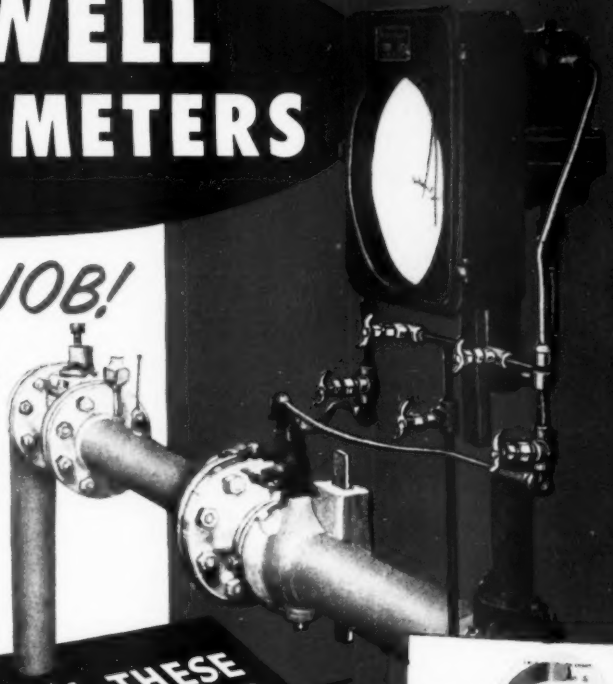
RIGHT ON THE JOB!

with IMPROVED MATERIALS, HEAVIER PARTS, GREATER ACCESSIBILITY

Right on the job . . . and right for the job, too. A favorite with the operating man who appreciates the clean-cut arrangement of internal units, the heavier parts of improved materials that permit Rockwell meters to stay on stream for long periods with minimum attention.

Management, too, has learned that Rockwell mechanical advantages pay dividends in the form of greater accuracy and longer life.

For orifice meter measurement at the lowest cost per cubic foot measured—specify Rockwell! Write for bulletin 1050.



ALL THESE FEATURES

ROCKWELL MANUFACTURING COMPANY

PITTSBURGH 8, PA. Atlanta Boston Chicago Columbus Houston Kansas City Los Angeles New York Pittsburgh San Francisco Seattle Tulsa

You Can RELY ON ROCKWELL

For Everything in Measurement and Control

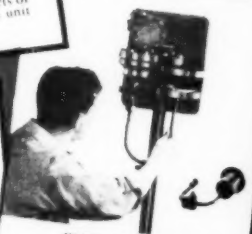
THE ROCKWELL INTEGRATOR
Mechanically Computing Orifice Meter Charts

Want to improve orifice meter accuracy, cut chart computation costs? Then investigate the Rockwell Integrator. Its use assures that the accurate recording made by the gauge will be converted into accurate totals with verified records of results. One machine will handle up to 300 average charts a day. Write for bulletin 1016.

CHART RANGE TAG
Tells at a glance the static and differential range of the meter.

LEAKPROOF STUFFING BOX
Has combination packing and bearing made of Teflon. All other parts of stainless steel. This unit is self-lubricated.

SERVICE CONVENIENCE
The entire meter can be disassembled and built up using common, everyday tools.



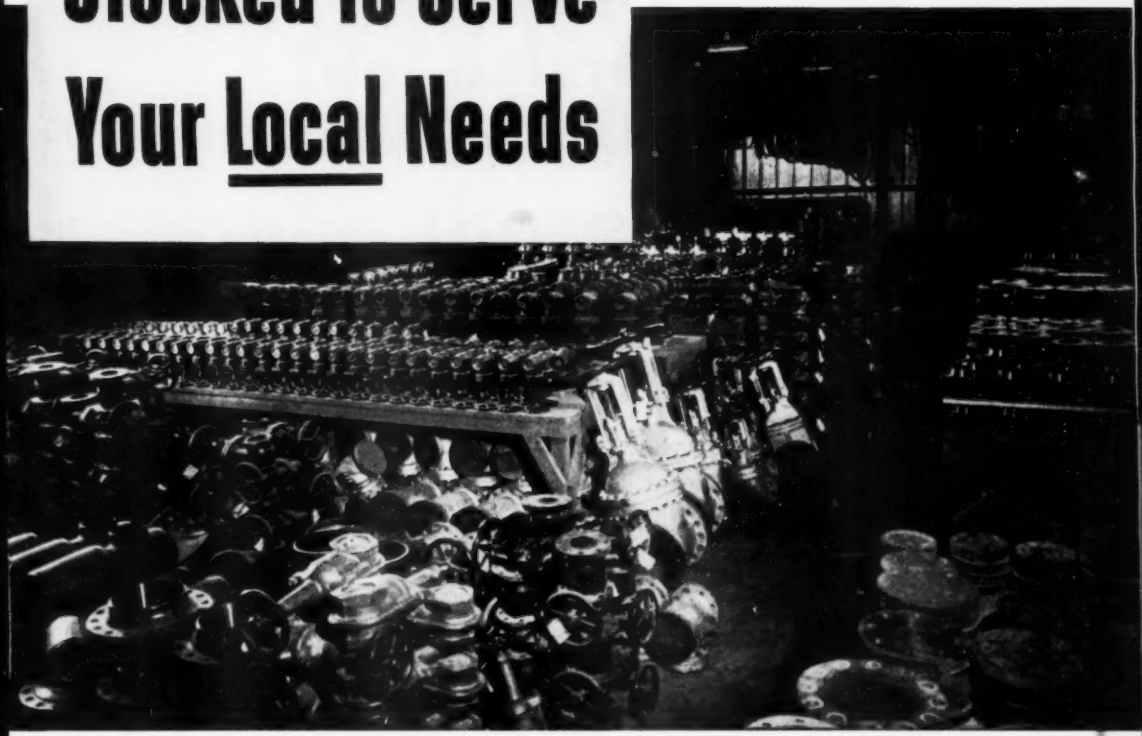
INTERCHANGEABLE HIGHSIDE CHAMBERS
The gauge can be quickly converted to any of four standard ranges—20 in., 50 in., 100 in., or 200 in. by simply exchanging one chamber for another.

STAINLESS PEN ARMS WITH MICROMETER ADJUSTMENT
Corrosion resistant stainless steel pen arms are painted different colors for ready identification. A simple micrometer adjustment is provided for zero setting.

ROCKWELL CHART DRIVE
Hermetically sealed. Standard type runs 8 days with one winding. Chart arbor turns once in 24 hours. Turret converters permit chart rotation rate to be changed at will.

POSITIVE INKING
Chart moves from underside of pen to top. Design prevents blurred or missing records.

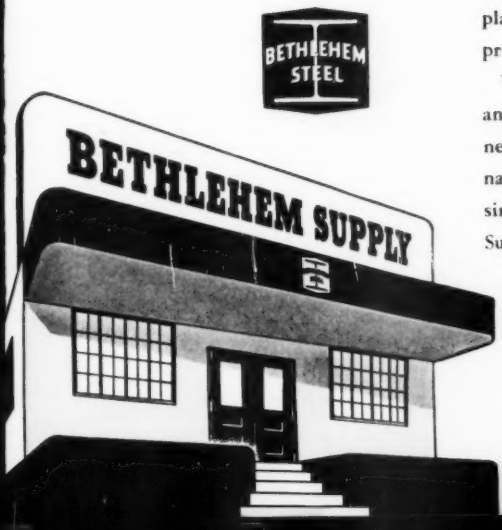
Stocked to Serve Your Local Needs



Each of the Bethlehem Supply stores is stocked with the items required in the region it serves.

This means that in a refinery center, the Bethlehem store carries supplies normally needed for refinery maintenance and construction work. Stocks meeting local requirements are also carried in areas having natural gasoline plants, petro-chemical plants, oil pipe lines, gas-transmission lines, and oil-producing properties.

When looking for valves, welding fittings and flanges, studs and nuts, hose and packing, tools, gages, or other quickly-needed items, call our nearest store. If in the market for furnaces, pumps, or allied types of products, you will find we can simplify the job of selection. This is one of the many Bethlehem Supply services that will prove helpful to you.



BETHLEHEM SUPPLY COMPANY

General Offices: 21 E. Second St., Tulsa, Okla.
West Coast Headquarters: Los Angeles, Calif.
Export Distributor: Bethlehem Steel Export Corporation

confronted with an oversize job?

. . . or a *small* one?

Driving Sectional Pipe Piles Inside Building with Hamm Mounted on Towmotor.

RAYMOND

has equipment to do both!

When you call in Raymond, you are turning your foundation work over to an organization which has specialized equipment, operated by expertly trained men, for pile jobs of any size. With 55 years of experience in foundation work ranging from a few test piles to more than 40,000 piles for one structure—Raymond has established a record for outstanding service.

THE SCOPE OF RAYMOND'S ACTIVITIES . . .
Soil Investigations, Pile and Caisson Foundations, Underpinning, Harbor and River Improvements and Cement-Mortar Lining of Pipelines by the Centriline and Tate Processes.

RAYMOND
CONCRETE PILE CO.
140 CEDAR STREET • NEW YORK 6, N.Y.
Branch Offices in Principal Cities of United States and Latin America

Looking up leads of Raymond Universal piledriver while driving precast concrete piles for Morganza (La.) Floodway Control Structure.

Only with B. F. Goodrich grommet belts can you make these savings!

Save 3 ways! Investigate today! Write or mail coupon

You save belt costs because belts last longer, save production costs because machines keep running with fewer interruptions, save maintenance costs because they need less attention.

Patented grommet belts by B. F. Goodrich represent the only basic change since invention of the V belt. Belts last 20 to 50 per cent longer, depending on service. (The more severe the service, the greater the increase over ordinary belts.) Grommet belts have more rubber; they're more flexible, give better grip, less slip.

What is a grommet?

A grommet is like a giant cable except that it's *endless*—a cord loop built up by winding heavy cord on itself. There is no overlapping cord *section* as in all ordinary belts. Most belt failures occur in these sections where cords overlap!

All cords put to work

Each of the two grommets and every part of a grommet carry their share of the load. In ordinary belts under high tension the center cords "dish" because tension is greater near the driving faces. Dished cords are doing less work, not pulling their share. Grommet belts have no center cords, there is no dishing—therefore much more strength in proportion to cord volume—and less stretch. Grommet belts stretch, on an average, only about one-third as much as ordinary belts.

Better grip, less slip

Grommet belts have more rubber in relation to belt size. Without any stiff overlap, they're more flexible, grip pulleys better. Size for size, grommet belts give ⅓ more gripping power, pull heavier loads with a higher safety factor. Because there is less slip, there is also less surface wear.

Send for proof

Send the coupon for a set of reports telling users' experiences and showing actual installations where grommet belts outlasted all others. Some typical cases:

"... within a few days ordinary belts had stretched ... After six months of 24-hour-a-day service BFG grommet belts haven't stretched at all ..."

"Ordinary belts lasted only 5 or 6 weeks ... B. F. Goodrich grommet belts are in their sixth month of service ..."

"Previous belts suffered from shock loads, wore out fast ... BFG grommet belts have been in service 2 years with no shut-downs..."

There are hundreds of cases like these.

They cost no more

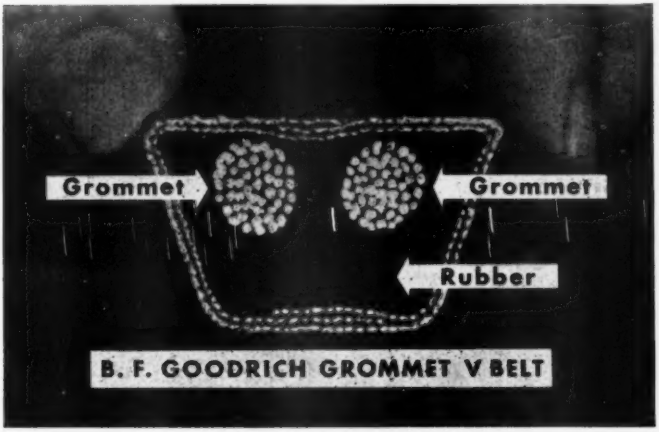
BFG grommet belts cost not one cent more than others. The savings they make for you are clear profit. They are made in C, D and E sections. They are patented by B. F. Goodrich. No other V belt is a grommet belt (U. S. Patent No. 2,233,294).

Write, send the coupon or see your B. F. Goodrich distributor. (He will show you his "X-ray" belt that shows the grommet construction clearly.)

Grommet V Belts BY

B.F.Goodrich

FIRST IN RUBBER



The B. F. Goodrich Company
Dept. OJ-3
Akron, Ohio

☐ Send set of reports telling users' experiences and showing actual installations proving that B. F. Goodrich grommet belts outlast all others.

☐ Have distributor show me the "X-ray" belt that shows how B. F. Goodrich grommet belts are made.

Name_____

Firm Name_____

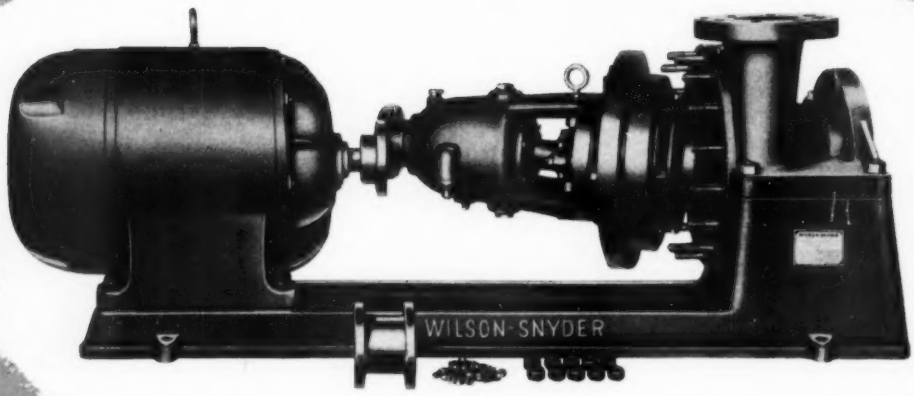
_____

Street Address_____

City_____

State_____

Look how EASY it is...
to dismantle for inspection or repair



Wilson-Snyder Type ES Centrifugal Process Pumps

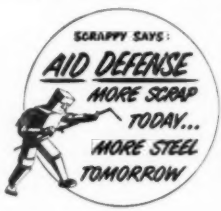
BY REMOVING the coupling spacer and nuts from the case-parting flange, Wilson-Snyder Type ES single-stage, single-suction process pumps, with vertically split case, can be dismantled for inspection without disturbing the driver or the piping.

These pumps are specifically designed for services where:

1. **continuity of operation is very important**
2. **temperatures or pressures may be very high**
3. **hot or cold liquids are handled near their boiling points**
4. **broad capacity range at high efficiency is desirable**

Design permits maximum interchangeability of parts. Only 3 sizes of bearing brackets, sleeves, packings, shafts and bearings are required for all 18 pump sizes, which provide capacity ranges from 40 to 1800 gpm with differential heads from 40 to 1000 feet and a speed range from 1750 to 4000 rpm with horsepower range from 2 to 250.

"Trims" can be furnished of any commercially available material which can be cast and machined, but standard stock materials include (a) 40,000-pound tensile cast iron, (b) low carbon cast steel, (c) 13% chrome stainless, type 410, (d) 18-8 stainless, types 304 and 316, (e) acid-resisting bronze, (f) 18-8 Stellited wear faces, (g) 4140 HT shaft and studs and (h) spark proof monel glands.



FOR FULL INFORMATION . . . or quotations on Wilson-Snyder Process Pumps, contact "Oilwell's" nearest refinery specialist at area office points shown below.

OIL WELL SUPPLY DIVISION
UNITED STATES STEEL COMPANY

Executive Office—DALLAS, TEXAS
Export Office—
30 ROCKEFELLER PLAZA
NEW YORK 20, N. Y.

Area Offices—CALGARY, CANADA
CASPER, WYOMING . . . COLUMBUS, O.
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Branches Serving All Oil Fields

USS TRADE MARK

"OILWELL" TRADE MARK

UNITED STATES STEEL

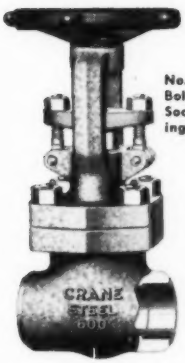
why CRANE 600-pound small steel gates are sure to meet your needs

You can't top these Crane Small Steel Gates for dependable performance on high pressure, high temperature lines . . . for ease of operation . . . for simplified maintenance. That's because they include design features normally found only in larger or more expensive valves.

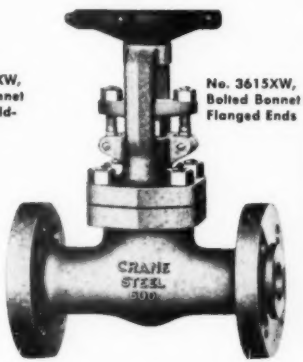
Then too, these Crane valves are available in a choice of types to meet your particular requirements. For example, with union or bolted bonnets; with screwed, flanged, or socket-welding ends; and in trim materials recommended for all common fluids.

GET NEW DESCRIPTIVE CIRCULAR AD-1881

For complete information—including prices—about these longer lasting, easier operating Crane Small Steel Gate Valves. Ask your Crane Representative for your copy, or write direct. No obligation.



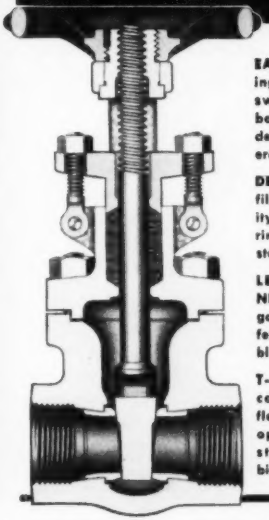
No. 3611XW, Bolted Bonnet Socket-Welding Ends



No. 3615XW, Bolted Bonnet Flanged Ends

UNION BONNET GATE. Screwed ends. Sizes: ¼ to 2-inch. Available in three different trim materials for a wide range of services. Also with socket welding ends

Easy to Operate... Easy to Service



EASY ACCESS to stuffing box assured by swinging gland eyebolts. Improved yoke design provides liberal working space.

DEEP STUFFING BOX filled with high quality asbestos packing rings maintains tight stem seal.

LEAKPROOF BONNET JOINT. Soft iron gasket in male and female joint cannot blow out.

T-HEAD DISC-STEM connection provides flexibility for smooth operation; prevents stem distortion or binding of parts.

Cross-section No. 3607XW, Bolted Bonnet Gate, Screwed

CRANE CO.

General Offices:
836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

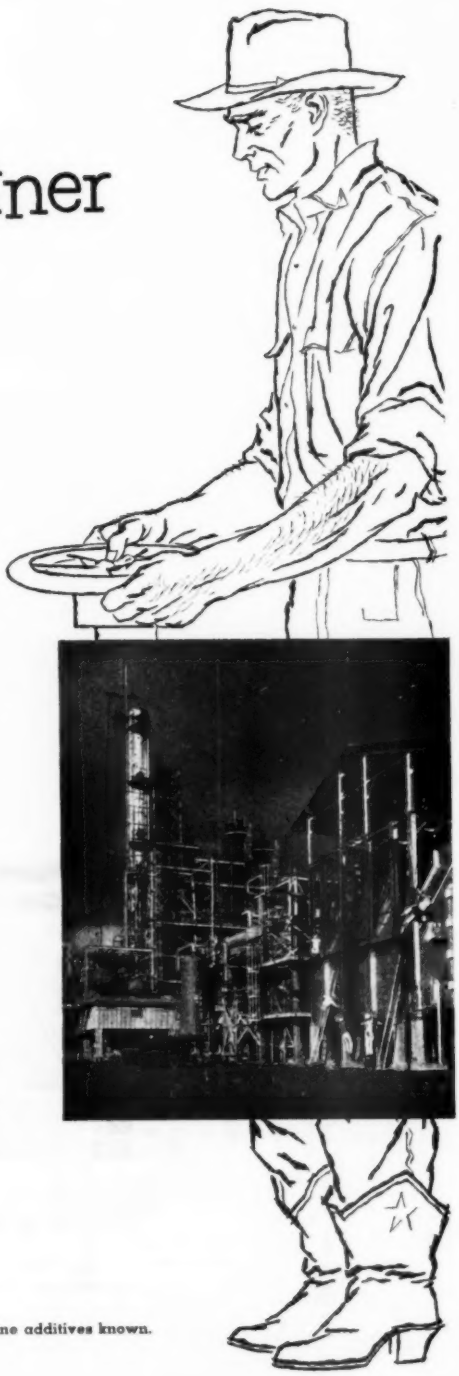
VALVES • FITTINGS • PIPE • PLUMBING • HEATING

The Oil and Gas Journal, published Mondays, copyright 1952, by The Petroleum Publishing Company. Entered as second-class matter September 1, 1910, at post office at Tulsa, Okla., under act of March 3, 1879. U. S. and foreign rates to the petroleum industry, $4 yearly

meet our partner

A few weeks ago, a long, tall Texan opened a valve in a pipeline on the outskirts of Longview, Texas. The whistle of the gas, as it started through that valve, marked the opening of a new division of the Eastman Kodak Company—Texas Eastman Company.

At the far end of the pipeline is a supply of gas from the greatest proven reserve of any oil field in the United States—the great East Texas Field. At the Longview end—the new Eastman chemical plant which will convert the natural gas and propane into potentially hundreds of chemicals vital to the production of textiles, plastics, lacquers and safety glass, to name but a few.



Texas Eastman is a separate division of Eastman Kodak Company. All of its products, however, will either be used by or sold through Tennessee Eastman Company. For the most part, these products will provide Tennessee Eastman with an economical source of raw materials for the manufacture of Tenite plastics, Eastman acetate yarns and fibers and the constantly expanding group of Eastman Industrial Chemicals.

▼

We are proud of our unbroken production record, and proud of our reputation for dependability. In a large sense, it is because of this pride that Texas Eastman Company has been built. For in so doing, we have assured ourselves of an uninterrupted flow of economical raw materials—and the supply of raw materials is the foundation of dependability.

Tennessee Eastman Company
Division of Eastman Kodak Company,
KINGSPORT, TENNESSEE

Manufacturers of TENAMENE — the most effective gasoline additives known.

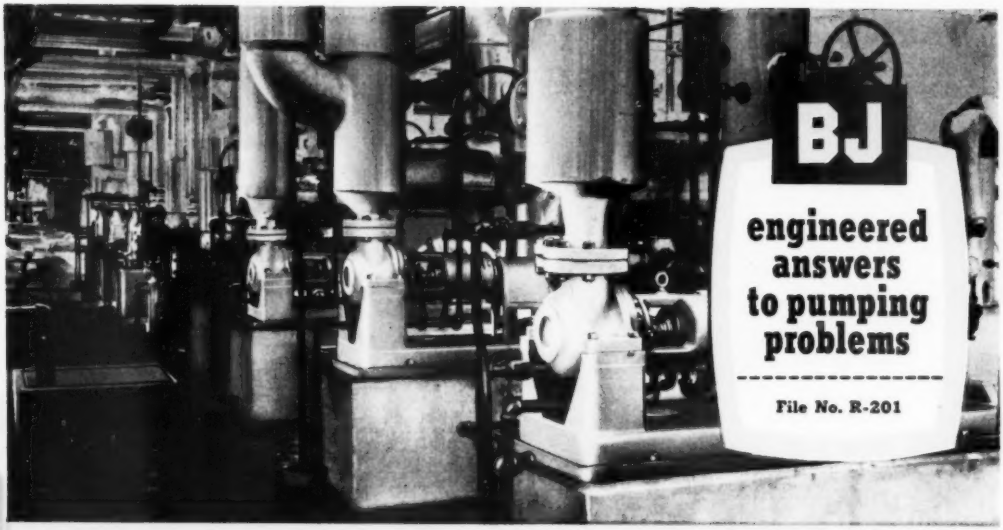
In this case it's refining, but whether the job be refining, pumping or transmission, you'll find Electric Power on the job — rendering safe, dependable, economical service. The top photo shows the new "cat" tower of a major oil company at Drumright, Okla. The bottom photo is a view of the refinery's storage facilities as seen from atop the tower. Here, as in countless other locales, Electric Power is doing the job Let *PEP go to work for you. Consult the Power Engineer of your nearest Electric Power Company for details on how you, too, can enjoy the many advantages of Electric Power.

*PEP — Purchased Electric Power

Petroleum Electric Power Association

ORGANIZED IN THE INTEREST OF GREATER SERVICE TO THE PETROLEUM INDUSTRY

CALL YOUR NEAREST ELECTRIC SERVICE COMPANY FOR MORE FACTS
OR ADDRESS YOUR REQUEST TO P. O. BOX 2771 DALLAS, TEXAS



First packaged TCC Unit features 20 BJ PUMPS...

The world's first packaged TCC unit, recently completed at Artesia, New Mexico, is a boon to the refiner of 12,000 barrels per stream day or less. This packaged plant—including feed preparation, catalytic cracking section, fractionation, gas plant and catalytic polymerization—increases gasoline yield and improves anti-knock rating at a cost factor which compares with much larger units.

In this unique installation Byron Jackson pumps of various types and sizes are used. In fact, of the 23 centrifugals installed, 20 are BJ pumps!

Whether you are concerned with pumps for a complete new refinery or a single replacement pump in an established operation, it pays to work with BJ. BJ's specialized knowledge and extensive line of refinery pumps assure you the *right* answer to your need.

Byron Jackson Co.
Since 1872
P. O. Box 2017, Terminal Annex, Los Angeles 54, California
OFFICES IN PRINCIPAL CITIES

FILE FACTS:

- Designed and built by the Southwestern Engineering Co., working with Socony Vacuum Oil Co., inventors and developers of the TCC process.
- Built for the New Mexico Asphalt and Refining Co., Artesia, New Mexico.
- Fresh feed capacity—6,000 bbl. per stream day of gas oil, operating at approximately 55 per cent conversion level.

No. of Units	Type of Pump	Capacity	HP	Application and Product Handled
2	2x3x11 H Fig. 1050	215 gpm	50	Charge Pump—Handles crude oil
1	3x4x8 H SM Process	310 gpm	20	Quench Oil Pump—Handles 650°F cycle oil
5	2x3x11 L Fig. 1050	100 gpm	30	Fractionator Reflux and Absorber Charge and Stabilizer Reflux Pumps with Type "U" Mechanical Seals
1	2x3x12½ H SM Process	110 gpm	40	Flasher Bottom Pump—Handles 725°F Residuum
1	3x4x8 L SM Process	180 gpm	10	Re-boiler Oil Pump—Handles gas oil
2	1½x2x8 H SM Process	45 gpm	5	Catalytic Poly Stabilizer Reflux Pump—Handles Butanes (Pumps have Type "U" Mechanical Seals)
1	1¼ TLM Bilton	30 gpm	5	Poly Reactor Wash Pump—Handles water
2	24 KXH Vertical Circulating	6000 gpm	250 and Turbine	Cooling Tower Pumps—Handles Cooling Tower Water for entire plant (Turbine drives through Philadelphia Right-Angle Gear)
2	1½ TLM Fig. 1025	105 gpm	2	Top and bottom Absorber Intercooler Pumps—Handles light hydrocarbons (With BJ Type "U" Mechanical Seal)
1	2x3x12½ H SM Process	64 gpm	30	Recycle Pumps—Handles recycle oil
1	3x4x8 H SM Process Pump			These pumps are used as common spares for the above services.
1	2x3x12½ H SM Process Pump			

TOTAL BJ PUMPS AT REFINERY—20

GET THESE *Outstanding Features* IN YOUR NEXT DIESEL

- ✓ "TRUE" DIESEL OPERATION
- ✓ UNIT FUEL INJECTION
- ✓ FOUR VALVES PER CYLINDER
- ✓ HYDRAULIC SERVO-TYPE GOVERNOR
- ✓ DISTORTIONLESS PISTONS
- ✓ INTERLOCKING CONNECTING RODS
- ✓ DUAL OVERHEAD CAMSHAFTS
- ✓ FLYWHEEL END CAM DRIVE
- ✓ EXTRA HEAVY CRANKSHAFT
- ✓ SYMMETRICAL DESIGN

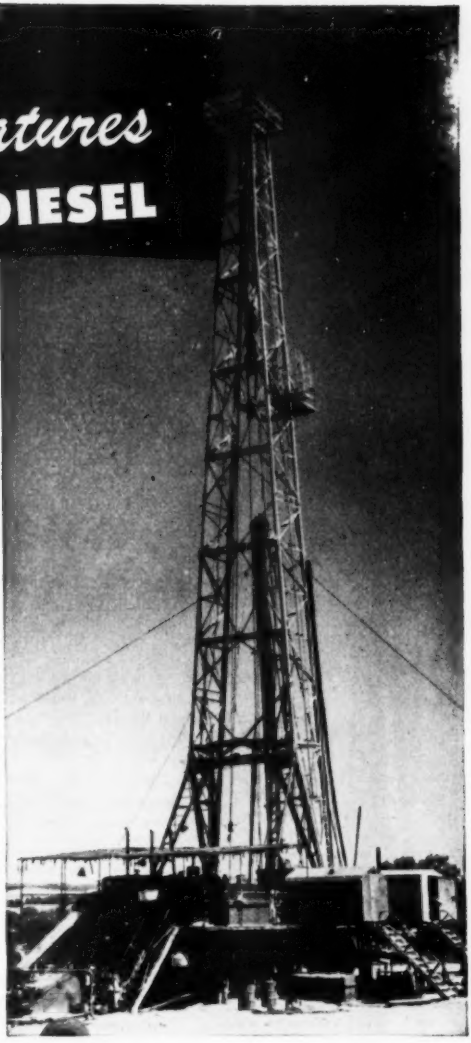
ONLY MURPHY DIESEL HAS THEM ALL and they mean more power . . . greater fuel economy . . . less down time . . . longer engine life. A complete description of all these features and many others—and what they mean to you—is given in the booklet "*10 Questions to Ask a Diesel Engine Salesman*". Ask your Murphy Diesel Dealer for a copy or write direct.

MURPHY DIESEL COMPANY

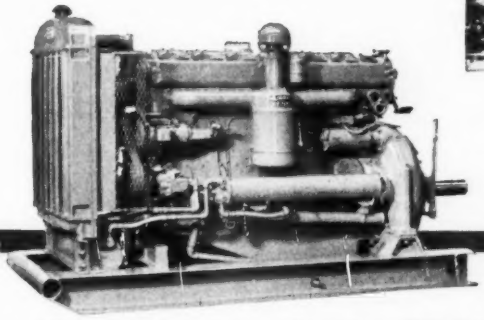
5305 W. Burnham St. Milwaukee 14, Wisconsin

OIL INDUSTRY FACTORY BRANCH Sales, Part Service:
113-117 South Elwood Street, Tulsa, Oklahoma

Sales, Parts and Service: Los Angeles, California; Evansville, Indiana; Great Bend, Kansas; Monroe, Louisiana; Tulsa, Oklahoma; Amarillo, Dallas, Houston, Odessa and San Antonio, Texas; and Edmonton, Alberta, Canada.



Rig of the Aztec Drilling Co., Aztec, New Mexico, which at the time this photo was made, was being used to drill a gas well near Lindreth, N. M. The rig is powered by three 150 H.P. (continuous) Murphy Diesels.

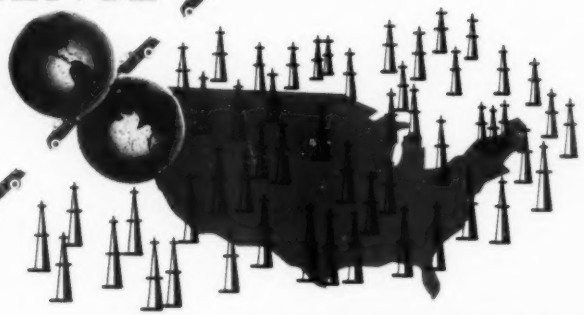


Heavy duty power for the oilfields

Murphy Diesel Engines and Power Units for drilling and pipe line pumping, 90 to 226 H.P., 1200 and 1400 RPM. Generator Sets, 60 to 140 K.W. Dual-Fuel Engines, 135 to 180 H.P. Also Crude Oil Burning Engines.

MURPHY DIESEL

MILLION-WELL EXPERIENCE



one of many reasons why HALLIBURTON'S *best* . . . for your DRILL STEM TEST!

There's no substitute for experience in servicing an oil well. And that makes Halliburton first in its field – for Halliburton *alone* offers you the enormous experience of service on more than a *million* wells!

Every one of these wells contributed its share to developing and improving Halliburton's Testing service, tools, and technology. The accumulated experience, evaluated and projected by Halliburton's energetic research program, is your firm assurance that Halliburton's best for your Drill Stem Test – today, tomorrow, and the years ahead!

More reasons why HALLIBURTON'S best:

ADVANCED AND HIGHLY SPECIALIZED TOOLS: Halliburton's present day equipment includes many exclusive features, such as the new curved J-slots, automatic locks, adjustable chokes, special-duty packers, multi-purpose circulating valves, and other features that make misruns a rarity with Halliburton.

GREATER ACCURACY IN PRESSURE RECORDING: Halliburton's exclusive Bourdon Tube Pressure Recording Device gives you far greater accuracy. The absence of packing glands in this instrument makes it much more sensitive to slight variations of pressure than other types. You get B.T.'s accuracy at no extra cost.

25 YEARS RESEARCH BACKS UP YOUR TEST. Halliburton's 25 years of grass roots research — the *only* big research program in the industry — has consistently solved field problems of testing. This energetic program will continue to meet the requirements no matter how deep the well, how high the temperatures or pressures.

YOU GET REAL PERSONAL SERVICE: Your tester stays on the rig from start to finish when Halliburton tests your well. This highly important operation requires close, full-time personal attention, and no one is more aware of it than your Halliburton Tester. He's fully prepared and equipped to give you a safe, accurate, successful test.

YOU'RE ONLY MINUTES AWAY: A Halliburton Testing Specialist can be at your well in a matter of minutes. There are 177 Halliburton camps strategically located in the oil producing areas of the U. S. and Canada. Phone your nearby camp and a Tester will have his string made up before you come out of the hole.

Get the million-well experience and the other exclusive Halliburton features on your next drill stem test. Phone your nearby Halliburton representative. Halliburton Oil Well Cementing Company, Duncan, Okla.

HALLIBURTON

YEARS AHEAD IN DRILL STEM TESTING

LANDIS PIPE THREADING MACHINES

. . . 4 Major Features Increase Efficiency

1. WIDE RANGE—Just three LANDIS Pipe Machines (2", 8" and 18") will thread all diameters of pipe from ½" to 18". Each machine is constructed so as to handle a wide range of pipe sizes—for example, the 6" machine will thread all diameters from 1" to 6". Universal size adjustment allows quick set-up.

2. DIE HEAD EFFICIENCY—The design of Stationary heads provides maximum rigidity on all diameters within their range. Positive locking action is assured through a self-locking toggle joint. Size adjustment is quickly and easily obtained through the use of a single locking nut.

3. LOW TOOL COST—Chasers operate at a tangent to the work. Line contact at cutting edge reduces friction. Permanent throat assures even chip distribution. Variable rake affords proper cutting edge for different materials. Landis chasers are useable for 80% of their original length. They are individually replaceable and, within the range of a given die head, a single set can be used for all diameters of the same pitch, form and taper.

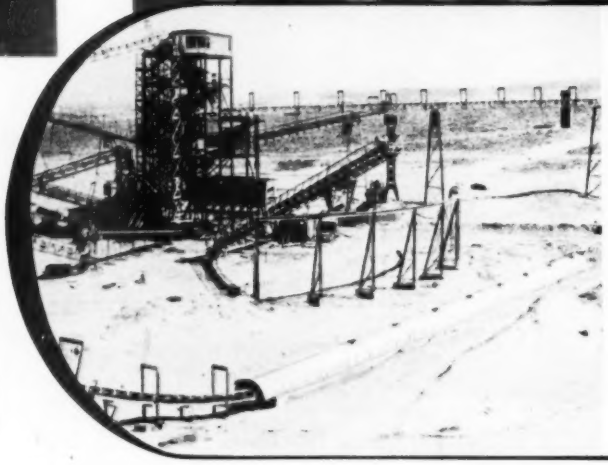
4. PRECISION TAPERED THREADS—The Receding Chaser Pipe Machines are especially designed to cut tapered threads to meet A.P.I. requirements. Chasers recede into the die head at a rate equal to the taper of the thread, ensuring accurate and uniform taper along the full thread length.

LANDIS *Machine* CO. WAYNESBORO PENNSYLVANIA

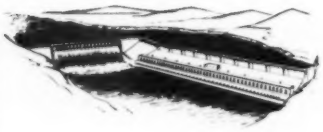
Represented in the Domestic Oil Fields by: Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; C. J. Harter Machinery, Houston, Texas; Frederic Baker Co., New Orleans, La.; Moore Machinery Co., Los Angeles and San Francisco, Calif.; Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo.

Industrial rubber products especially built for LONG SERVICE

PIONEER



Pioneer Belting selected for 3,000,000 ton aggregate job



Part of the plant which will furnish rock and sand for Chief Joseph Dam.

Three million tons of crushed rock and sand will be used in the building of Chief Joseph Dam, now under construction on the Columbia River.

A most unusual crushing, screening, and washing system is in use, and thousands of feet of Pioneer Conveyor Belting keep the operation on schedule. Every hour, 400 tons of aggregates are carried to the concrete batching plant, which will produce 1¾ million cubic yards before the job is finished.

Extreme summer heat, winter cold, moisture, abrasion, and gouging—these are some of the things this Pioneer Belting is built to withstand. Like Pioneer Conveyor Belting used on other difficult construction jobs, it will turn in a fine performance record.

Pioneer Rubber Mills has had 63 years of experience in engineering industrial rubber goods for *long life* under the most exacting conditions.

Call your nearest Pioneer representative. He will be glad to give you any information you require—fast!

Send for Pioneer's newest booklet, "METABOND," a complete handbook on rubber linings, coverings, rubber covered rolls.

PIONEER RUBBER MILLS

Pioneering in rubber since 1888

BRANCHES: CHICAGO · CLEVELAND · DALLAS
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Pioneer Manufacturers of a Complete Line of Industrial Trucks

SPECIAL ATTACHMENTS AVAILABLE FOR THE PETROLEUM INDUSTRY

Lift Trucks for the Petroleum Industry

HYSTER 20

Capacities — 1000-2000 pounds
Width — 37 inches
Length — 71 inches (less forks)

HYSTER 40

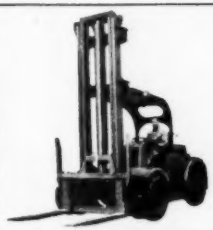
Capacity — 4000 pounds
Width — 43 inches
Length — 86 inches (less forks)

HYSTER 75

Capacity — 7500 pounds
Width — 60 inches
Length — 117½ inches (less forks)

HYSTER 100

Capacity — 10,000 pounds
Width — 86 inches
Length — 148 inches (less forks)



HYSTER 150

Capacity — 15,000 pounds
Width — 86 inches
Length — 148 inches (less forks)

HYSTER TURRET TRUCKS

PALLET TRUCK

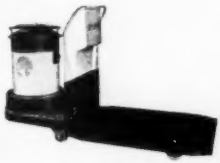
Capacity — 4000 pounds
Width — 35 inches
Length — 86", 92", 98", 104", 110"

TUG

Width — 42 inches
Length — 62 inches

PLATFORM TRUCK

Capacity — 4000 pounds
Width — 35 inches
Length — 97", 103", 115"



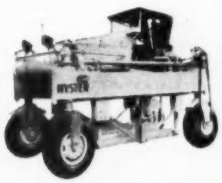
CARGO TRUCK

Capacity — 4000 pounds
Width — 42 inches
Length — 103½ inches

Straddle Trucks

M STRADDLE TRUCK®

Capacity — 18,000 lbs.
Package Size — (48"x40") to (66"x52")
Length — 176 inches



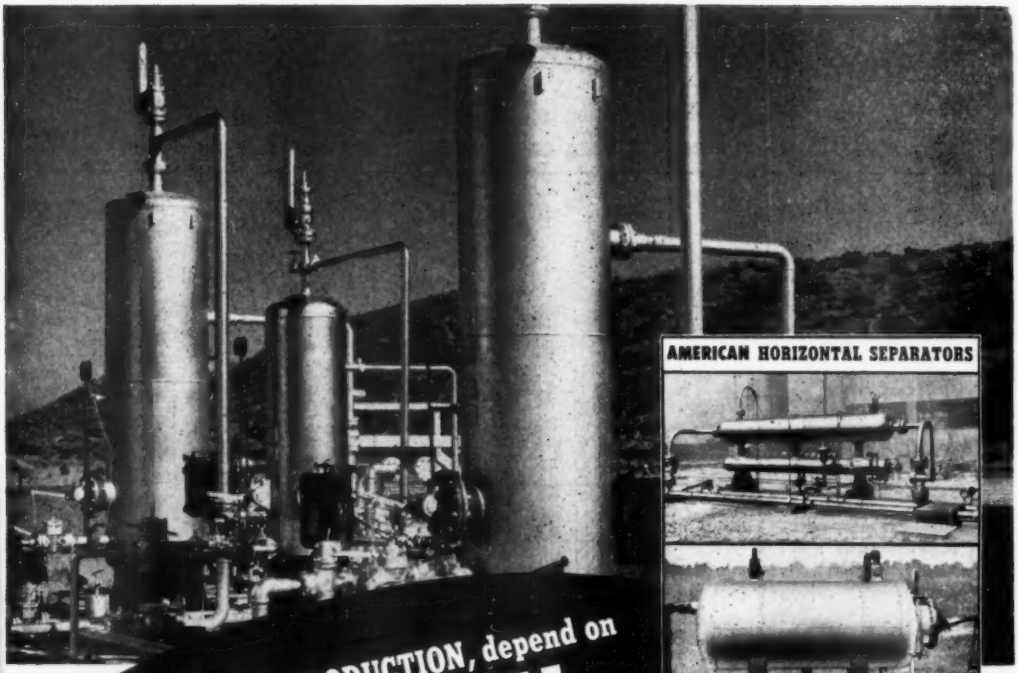
MH STRADDLE TRUCK®

Capacity — 30,000 pounds
Package Size — (54"x40") to (66"x64")
Length — 190½ inches

MOBILE CRANE

HYSTER KARRY KRANE®

Capacity — 10,000 pounds
Width — 76 inches
Length — 152 inches

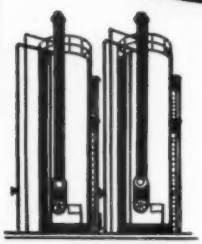


AMERICAN HORIZONTAL SEPARATORS

for IMPROVED PRODUCTION, depend on

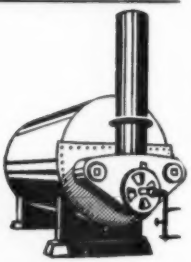
AMERICAN NATIONAL OIL & GAS SEPARATORS

EMULSION TREATERS • LINE HEATERS



AMERICAN-NATIONAL EMULSION TREATERS

These modern treating plants are scientifically engineered for maximum capacity and continuous duty operations. Dehydrated crude reduces corrosion, increases volume in tanks, pipe lines, refining plants.



AMERICAN-NATIONAL LINE HEATERS

These portable, automatic units meet your needs for either high or low pressure operation. Wide size range for any capacity gas or oil production.

Dependable American-National Oil & Gas Separators—vertical, or portable horizontal models—are built to meet your specific needs—in sizes, working pressures and capacities for most efficient production—under any of several construction codes, depending upon your preference and safety requirements. Behind every unit stands American's 46 year reputation for quality—and their 100% guarantee of materials and workmanship. Contact us today.

AMERICAN PIPE & STEEL CORPORATION

Engineers • Designers • Fabricators • Erectors
2201 West Commonwealth Avenue, Alhambra, Calif.
Cable address: AMPSTEEL
Bakersfield: U. S. Highway 99 & Casa Loma Dr.

PROVED BEST
TO PREVENT OR RESTORE LOST CIRCULATION . . .

HALLIBURTON PALCO SEAL

Fluffy redwood fiber chips have proved best of the drilling mud additives to prevent or restore lost circulation. Palco Seal is selected grade redwood chips, carefully processed into durable, dry, fluffy fibers, and compressed into uniform bales.

Halliburton's Palco Seal is most efficient and economical. Some of the many advantages it offers are:

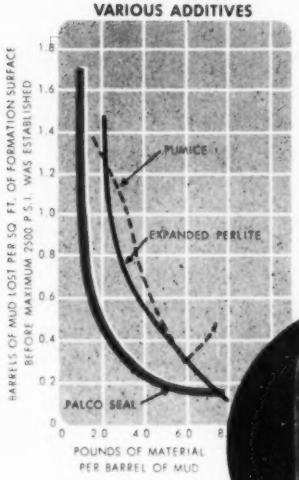
★ Convenient uniform bale size for storage and ease of handling at well.

★ Low volume required to accomplish outstanding results—3½ to 6 lb. to the barrel of mud.

★ Keeps indefinitely, doesn't spoil or deteriorate. Can be stored outside or held in mud pit ready for use.

★ Improved sealing qualities, fibers swell up to 5% by volume when saturated with drilling fluid.

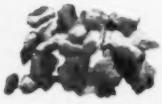
COMPARATIVE SEALING PROPERTIES OF VARIOUS ADDITIVES



You can avoid lost circulation problems easily and simply by adding Palco Seal to the mud tanks. For overcoming the more stubborn mud problems Halliburton mixes Palco Seal and Flocele with excellent results. Before your next drilling job, check with your nearby Halliburton representative for full information on this tested and proved additive. Halliburton Oil Well Cementing Company, Duncan, Okla.

YEARS AHEAD IN PRODUCTION IMPROVEMENT TECHNIQUES

HALLIBURTON



Oil and gas men know the importance of "bone dry" petroleum products. They also know that ALCOA *Activated* Alumina is one of the oldest . . . most reliable . . . thoroughly proved drying agents in the petroleum industry.

ALCOA *Activated* Alumina, earning its reputation the hard way, has *proved* its superiority, year-in, year-out, in hundreds of steady, reliable dehydration jobs. Particularly efficient in drying furnace oil and gasoline, instrument air and other gases, it has effectively solved the problems of moisture in finished products in storage or in pipe lines.

ALCOA *Activated* Alumina is highly adsorptive . . . easy to handle . . . abundantly available . . . and easily regenerated. It is one of the few desiccants that will not shatter on contact with water. It has high resistance to crushing, shock and abrasion. Moreover, this highly inert aluminum oxide dries to *lower dew points* than any other commercial adsorbent!

ALCOA *Activated* Alumina can speed up your processes . . . can save *your* money. Let us tell you how. Write to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 618C Gulf Building, Pittsburgh 19, Pennsylvania.

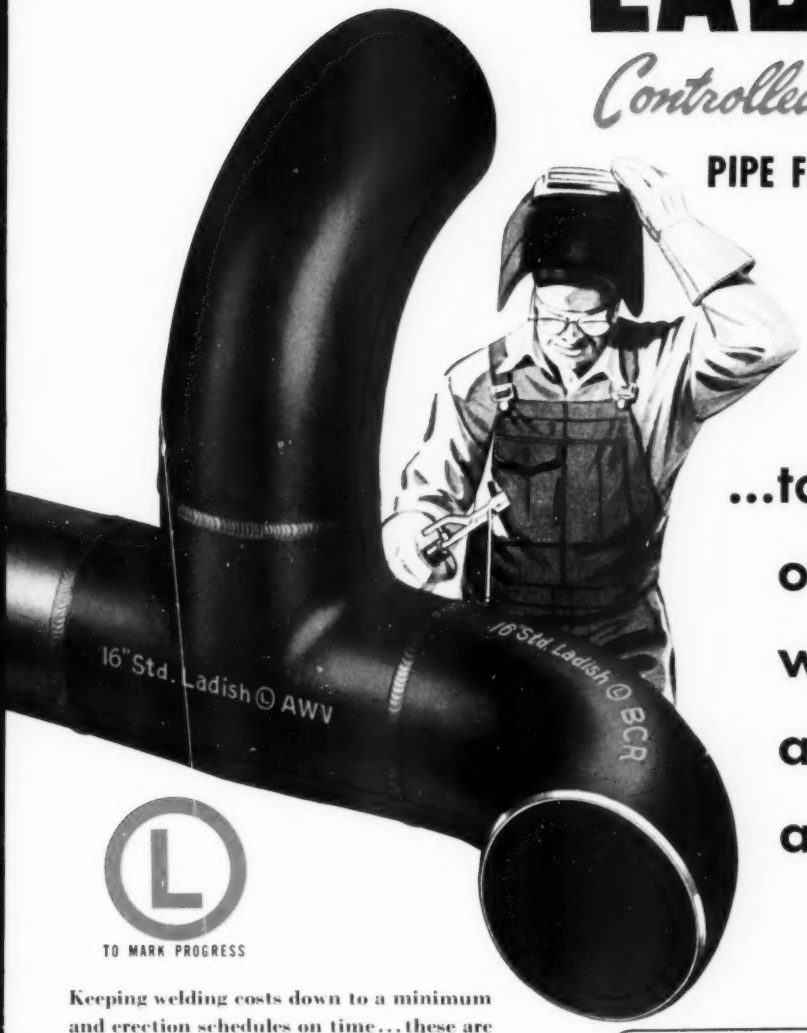
"SEE IT NOW" with Edward R. Murrow, brings the world to your armchair . . . CBS-TV every Sunday—3:30 P.M.—E.S.T.

IT ALWAYS PAYS TO SPECIFY

LADISH

Controlled Quality

PIPE FITTINGS



...to be sure of sound welds and fast assembly

TO MARK PROGRESS

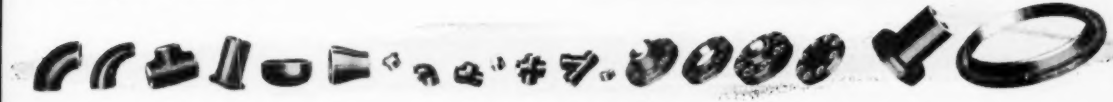
Keeping welding costs down to a minimum and erection schedules on time... these are important advantages you can assure to any piping job by installing Ladish Controlled Quality fittings. Metallurgical controls over materials and methods provide an assurance of uniform weldability in every Ladish fitting... and thorough inspection to rigid standards of physical dimensions and geometric accuracy assures fast piping assembly.

THE COMPLETE *Controlled Quality* FITTINGS LINE
PRODUCED UNDER ONE ROOF...ONE RESPONSIBILITY

LADISH CO.

CUDAHY, WISCONSIN
MILWAUKEE SUBURB

District Offices: New York • Buffalo • Pittsburgh • Philadelphia • Cleveland • Chicago • St. Paul
St. Louis • Atlanta • Houston • Tulsa • Los Angeles • Havana • Toronto • Mexico City



Du Pont Ammate®
WEED KILLER

Keeps Brush Down With Fewer Sprays

LOWER COST TO KEEP BRUSH DOWN. Many users report "Ammate" sprays once every five years keep down the brush on their rights-of-way. And "Ammate" kills more kinds of brush and woody plants, roots and all, than most other weed killers.

SAVES LABOR AND EQUIPMENT. Fewer sprays—so maintenance crews can cover more ground on a long-term basis. "Ammate" develops efficiency in brush control.

PROVIDES SAFETY FACTOR. "Ammate" does not leave the soil unproductive, so grass and low growth come back to control erosion. With "Ammate" there is less danger of spray drift damage, for "Ammate" spray is not volatile.

KINGPIN FOR YOUR BRUSH-CONTROL PROGRAM. Use "Ammate" for general brush control. Du Pont 2,4,5-T, 2,4-D and TCA are recommended for certain brush or weeds which they control well.

Get this free illustrated booklet *describing industrial brush control with Du Pont "Ammate" and other Du Pont brush killers. For further details, write:*

DU PONT, GRASSELLI CHEMICALS DEPT.
5031 DU PONT BLDG.
WILMINGTON, DELAWARE

DU PONT
REG. U.S. PAT. OFF.
Ammate®
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

BIG Tractor-shovel with BIG push

4-wheel drive PAYLOADER®

The big 1½ cu. yd., 75 horsepower Model HM "PAYLOADER" has proven itself in the oil industry as a valuable, versatile earth mover. It gets to the job faster under its own power at speeds up to 16 mph . . . has traction and flotation to work on poor grounds . . . can excavate, load trucks, backfill, bulldoze, spread, pull, push, lift and carry. It's a many-purpose handyman for the pipe liner, the driller and the refiner.

This tractor-shovel also makes a hit with operators because it rides easy and has a big comfortable seat, power-boosted steering and fingertip hydraulic control. Four speeds *reverse* as well as forward permit as fast operation in both directions as the job conditions allow, and there's a choice of gasoline or diesel power. Once you've seen a Model HM in action you'll understand why hundreds of owners and operators are its enthusiastic boosters.

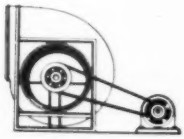
The Frank G. Hough Co., 749 Sunnyside Ave., Libertyville, Ill.

WRITE for catalog on the 1½ yd. Model HM or the six other "PAYLOADER" sizes down to 12 cu. ft. bucket capacity.

PAYLOADER®

"Buffalo" *Tips on Getting the Best Service from your* **Fans**

MAKING THE RIGHT SELECTION

AXIAL FLOW? or CENTRIFUGAL? 

Centrifugal fans like this "Buffalo" Limit-Load model are generally the first choice for large ventilation, exhaust and air conditioning systems. Their efficiency is high even when installation is at a curve in the duct. Medium speed fans, they are ideal for handling large volumes of air quietly at medium pressures. "Buffalo" Limit-Load Fans have the additional advantage of being non-overloading, regardless of the system pressure. For further factors in the selection of a centrifugal fan, write for Bulletin 3737.

"Buffalo" BUILDS BOTH TYPES—

Axial Flows, on the other hand, move air by the propeller principle, straight through the fan housing. These fans will thus be most efficient mounted in straight runs of duct. They are ideal for light-duty ventilation and air conditioning service at pressures to around 2". Axial flows are higher velocity fans than centrifugals, are lighter weight and more compact than centrifugal fans, therefore lower cost for cut-mounting on ceilings, walls, etc. However, the performance curve is often the last analysis in your choice of fan for each job. "Buffalo" Bulletin 3533-C contains a comparison performance chart of both "Buffalo" Limit-Load Fans and Axial Flows. A copy will be mailed to you on request.

"Buffalo" FIRST FOR FANS

BUFFALO FORGE COMPANY

525 BROADWAY BUFFALO, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont. Branch offices in all Principal Cities

VENTILATING FORCED DRAFT | AIR WASHING COOLING | AIR TEMPERING HEATING | INDUCED DRAFT EXHAUSTING PRESSURE BLOWING

REPUBLIC ROTARY HOSE

HAS LEAK-PROOF COUPLING!

The nipple built into Republic's Champion Rotary Drilling Hose gives you a full-flow, boltless coupling. The leak-proof seal gets tighter under pressure.

Here's How It Works

The nipple (1) is built in between the metal reinforcements of the hose carcass (2) and (3). The inner reinforced rubber structure (2) is anchored within the nipple and locked into leak-proof engagement by a brass expansion ring (4). This expansion ring is protected by a steel guard ring (5). As pressure pushes the reinforcing rubber structure (3) against the nipple assembly, a leak-proof union is established. The higher the pressure the tighter the seal. The cover cap (6) screws into position over the nipple assembly, and has the same OD as the hose. No projections. This cap is held in position by submerged set screws and anchor cap seals (7). A rubber gasket (8) seals the joint between cap (6) and end of nipple (1).

Republic's Champion Rotary Drilling Hose has built-in steel muscles. It is flexible, but remarkably strong. Shrugs off oil, abrasion, and other hose enemies. Furnished in standard lengths up to 60 feet.

REPUBLIC RUBBER

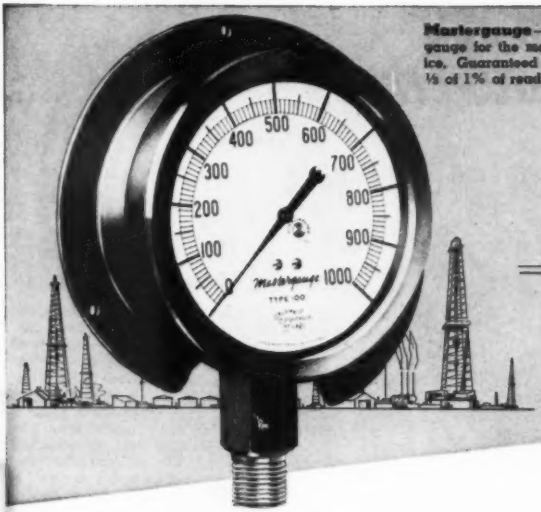
AMERICA NEEDS SCRAP TO MAKE MORE STEEL

Jones & Laughlin Supply Company

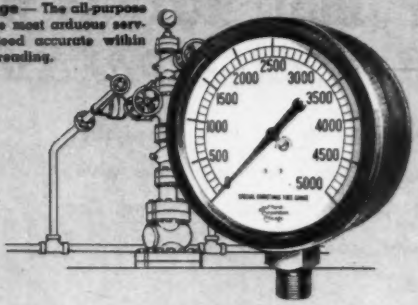
J&L STEEL

STORES • OFFICES • RESIDENT SALESMEN

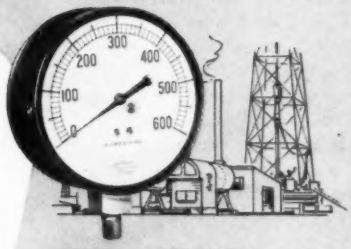
General Offices: TULSA, OKLAHOMA



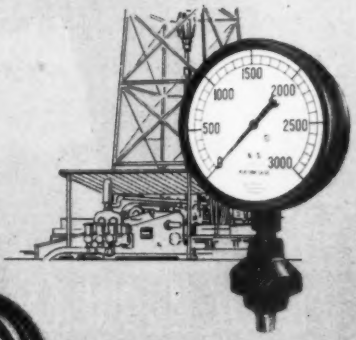
Mastergauge— The all-purpose gauge for the most arduous service. Guaranteed accurate within ½ of 1% of reading.



Christmas Tree Gauge—Specially made for Christmas trees. These gauges incorporate ruggedness and accuracy beyond all others.



Oil Country Boiler Gauge— The mastergauge specially made for oil country boilers.



Mud Pump Gauge—The Mastergauge with protecting diaphragm of advanced design.

Hydraulic Gauge — Finest of hydraulic gauges in pressure ranges up to 30,000 lbs. per sq. in.

Instruments that set their own standards

So tough are the demands imposed upon pressure gauges in the oil country that even instruments considered good by ordinary standards often fall down on the job.

Producing gauges that would stand up under such conditions called for totally new standards of design, quality, workmanship. How well we achieved these higher standards in Marsh gauges is eloquently attested by thousands of instruments in service.

Yes, Marsh Gauges have been accorded top preference in the petroleum industry because they have set new standards all their own.

Ask for bulletins describing Marsh Gauges specifically designed for the oil industry.

MARSH INSTRUMENT CO.

Sales affiliate of Jas. P. Marsh Corporation

Dept. L, Skokie, Ill.

HOUSTON BRANCH PLANT: 1121 Rothwell St.
Sect. 15, Houston, Texas

The Marsh branch plant at Houston offers shipment from stock and facilities for repairing all makes of gauges.

MARSH GAUGES

Some important facts for men concerned with...

REDUCING EQUIPMENT MAINTENANCE and REPLACEMENT COSTS

WHICH POLISHED ROD has seen greater corrosive service? Rod on left, showing effects of serious pitting and corrosion, is a steel rod used about 3 months in an Oklahoma field. Rod on right is Monel, after 5 years' service in the same well.

AFTER A 104-DAY RUN in sour crude, this standing valve puller brought out the standing valve on the first try. Note the effects of corrosion on the steel crown of the puller. Compare with Monel spring which is still in excellent condition.

In corrosive wells, Monel® equipment sets records for economy and long life.

Monel *lasts* where the going is tough – in gas lift devices, pump parts, orifice plates, and many other types of oil field equipment.

Here's why. Like all INCO Nickel Alloys, Monel is non-rusting. It is highly resistant to the corrosive action of sour crudes. It does not accelerate corrosion in other metal parts. It withstands cutting by high-pressure gas, resists abrasion and erosion by entrained solids over wide ranges of temperature, pressure and velocity.

In addition, Monel possesses great tensile strength and exceptional toughness. (See table of Mechanical Properties.) When used for parts subjected to alternating stresses in the presence of corrosives, Monel's retention of fatigue strength is particularly evident in lengthened equipment life.

Years of service in unusually corrosive areas – notably those of west Texas and New Mexico – *prove* the superiority of Monel for use under conditions that rapidly weaken and destroy less rugged metals.

Consider Monel whenever you need a tough metal for a tough job. Write for our illustrated booklet, *Controlling Corrosion in Petroleum Production Equipment*. It contains individual sections dealing with exploration and drilling, pumping, and gas control. It brings you the details of typical performance and service records.

This booklet also tells how you can get free technical advice on the selection of materials for severe service, and contains a listing of valuable bulletins and literature that have been prepared for your use. Write us – *now* – for your copy. No obligation.

MECHANICAL PROPERTY RANGES OF MONEL

Form and Condition	Tensile Properties			Hardness
	Yield Strength (0.20% offset) 1000 psi.	Tensile Strength 1000 psi.	Elongation in 2 in. per cent	Rockwell B
Rod and Bar				
Cold drawn				
Annealed	25-40	70-85	50-35	60-75
As drawn	55-120	85-125	35-17	85-23*
Hot rolled	40-65	80-95	45-30	75-90
Forged, High Tensile	60-85	85-110	30-20	84-97
Sheet and Strip				
Std. c.r. sheet	25-45	70-85	50-35	61-73
Spec. c.r. sheet and strip				
Annealed	25-45	70-85	50-35	73 max.
Hard sheet	90-110	100-120	15-2	93 min.
Full-hard strip	90-130	100-140	15-2	98 min.
"35" sheet	45-65	78-85	40-20	74-89
Tubing, cold drawn				
Annealed	25-45	70-85	50-35	75 max.
Stress Equalized	65-120	85-125	30-10	90-23*

*Rockwell C Scale

Today, with much of Inco's Monel being absorbed in defense activities, delivery difficulties may occur. To reduce the chance of costly delays, anticipate your needs . . . remember to order well in advance *giving necessary N. P. A. ratings* and complete end use information. Also remember, for helpful advice on special problems, consult our Corrosion Engineering Service . . . just write, giving full details.

EMBLEM OF SERVICE INCO

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street, New York 5, N. Y.

MONEL... *YOUR PARTNER IN PROGRESS*

Bingham

PRECISION BUILT FIELD PROVEN PUMPS

Stuffingboxless PIPE-LINE Pumps

Bingham Stuffingboxless Pumps are unique for pipe-line service. They *have no stuffingboxes — no packing — no external moving parts — no adjustments — require no operating attendants.* They are unaffected by high or variable suction pressure — hence, can be operated singly or with several units in series. They can be safely installed for outdoor service regardless of weather conditions.

Pumps of this type are being used successfully by major pipeline companies in automatically controlled unattended pipeline booster stations with resultant large savings in the cost of both installation and operation.

• • •

There are more Bingham Stuffingboxless Pipe-line Pumps now operating in unattended stations and on order than the total number of pumps of all other makes used for this service.

Bingham Stuffingboxless Pumps, like all Bingham products, are precision built in our new and modern plant.

One of several Bingham High Pressure Stuffingboxless Pumps operating in unattended automatically controlled booster stations on Wyco Pipe-line.

SEND NOW

FOR STUFFINGBOXLESS FOLDER NO. 107

Lists 12 important reasons why you can profit by using Bingham Stuffingboxless Pumps. Write, write, or phone the Bingham Sales and Service office nearest you.

Bingham

DOUBLE VOLUTE RADIAL BALANCE

PUMPS SINCE 1921

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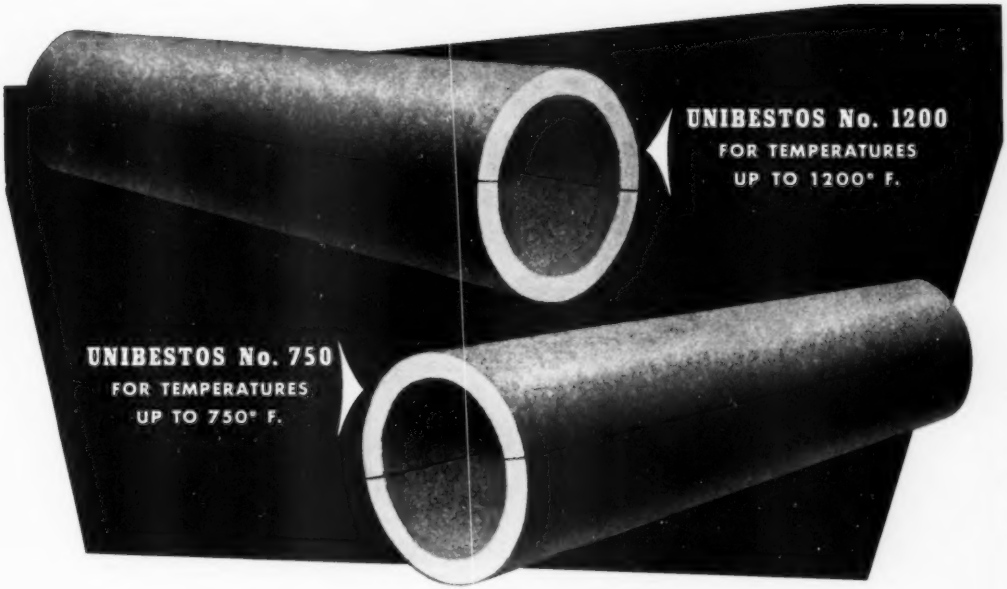

These famous UNIBESTOS twins cut heat loss and surface temperature

HIGH EFFICIENCY IS UNIMPAIRED BY REUSE OR CONTINUOUS SERVICE

When you insulate with Unibestos you can be sure of *prolonged* effectiveness, for this durable African Amosite product resists all service hazards. It's unaffected by moisture, steam, fumes . . . withstands impact and vibration . . . won't shatter, crumble, powder, or dust to contaminate the atmosphere under normal service conditions.

Unibestos is easy to cut and fit . . . brings you the added economy of *single-layer* application . . . may be removed and reused repeatedly without damage or loss of efficiency. Adjacent sections can be stapled together to prevent separation due to expansion.

Phone your Unarco Distributor for *money-saving* Unibestos in cylinders, half-rounds, or blocks.

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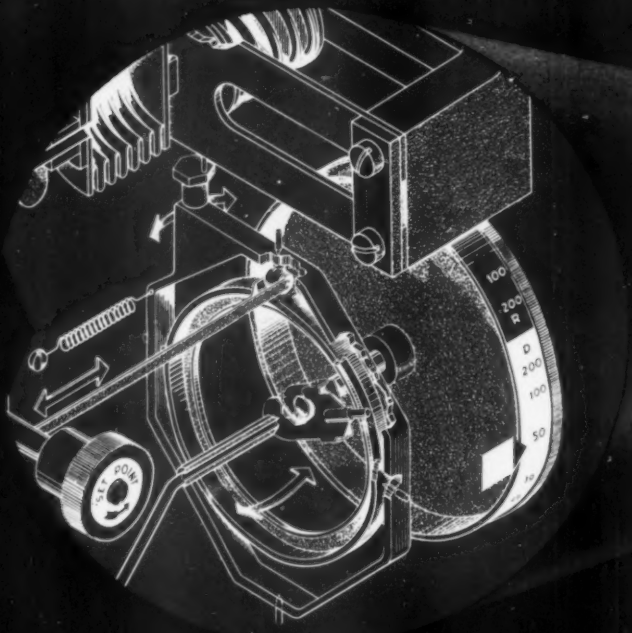
HERE IS A *Completely*



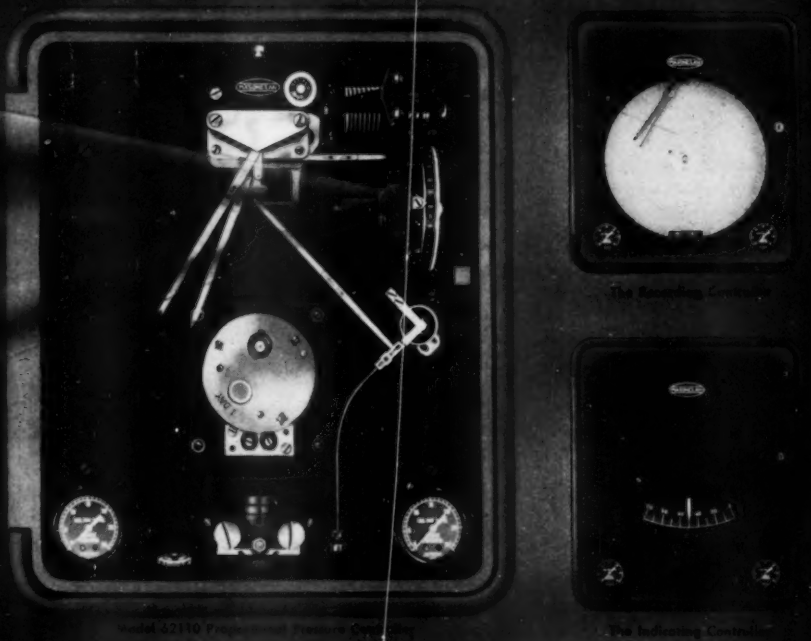
THE GIMBAL UNIT

ONE control mechanism gives you **FOUR** combinations of primary and feedback motion to obtain Direct Proportional, Reverse Proportional, Direct Differential-gap and Reverse-Differential-gap Control.

With **ONE SETTING** you select type of control, type of action and proportional band or differential-gap setting.

A HIGH C_Q PRODUCT

New CONTROLLER



MODELS NOW AVAILABLE

Recording and indicating types are now available for pressure, temperature, liquid level or flow service with the following types of control:

Proportional (includes Differential-gap and On-Off)

Proportional-Reset

Plus these supplementary types—

Pneumatic Set — for remote setting of control point

Time Cycle — features cam drive independent of chart drive

Differential—maintains positive or negative differential between two variables — to 50% of chart range.

Also available are Recorders, Transmitters, and Manual Control subpanel with four-position transfer switch.

MASON-NEILAN REGULATOR CO.

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Sales Offices or Distributors in the Following Cities: New York • Syracuse • Chicago • St. Louis Tulsa • Philadelphia • Houston • Pittsburgh • Atlanta • Cleveland • Cincinnati • Detroit San Francisco • Salt Lake City • El Paso • Boise • Albuquerque • Charlotte • Los Angeles • Denver Appleton • Corpus Christi • New Orleans Mason-Neilan Regulator Co., Ltd., Montreal and Toronto

"Safe" under any conditions

EXPLOSION-PROOF MOTORS

Louis Allis explosion-proof motors have the Underwriters' Laboratories approved labels for all types of hazardous conditions—Class I, Group D for explosive liquids and vapors; Class II, Group G for combustible dust; Class II, Group F for carbon black, coal and coke dust; Class II, Group E for combustible metal dust.

There is a modern streamlined Louis Allis Explosion-Proof motor to satisfy your most exacting specifications. A careful comparison and analysis will show you that Louis Allis Explosion-Proof motors offer you more dependable performance, convenience, long life and safety.

For quick, dependable service contact your nearest Louis Allis Sales Engineers.

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THE LOUIS ALLIS CO., Milwaukee 7, Wis.

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1927 • 1952
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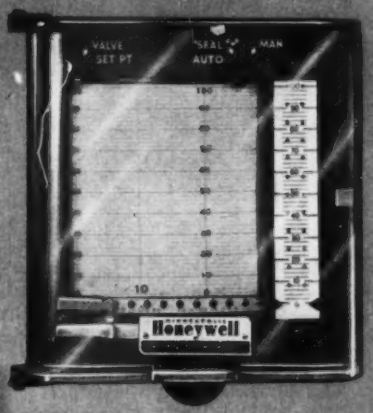
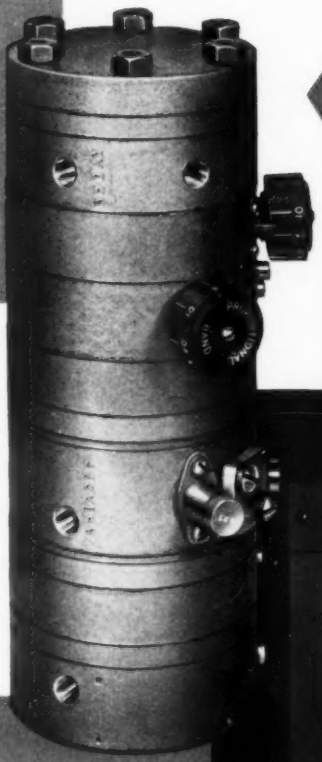
Important



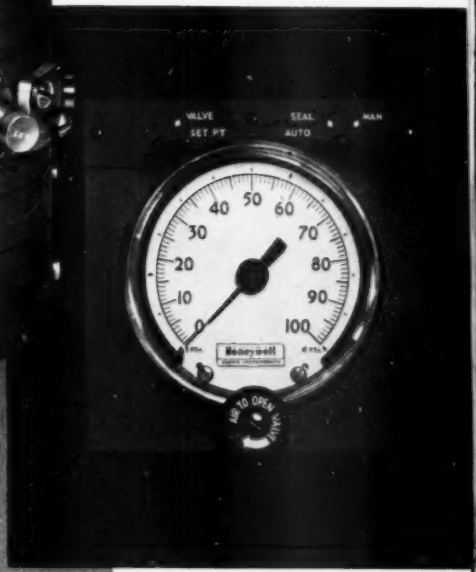


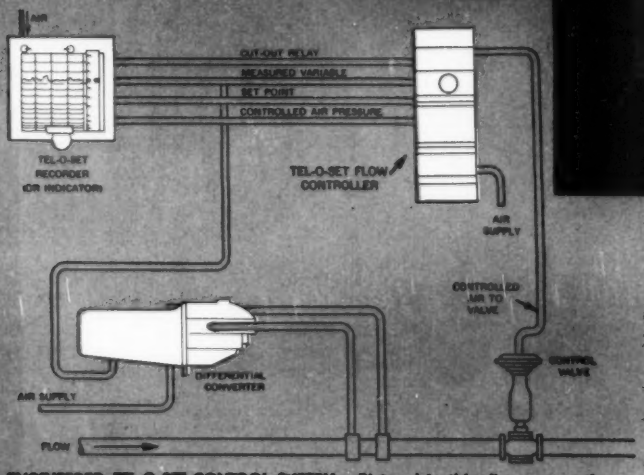
TEL-O-SET CONTROLLER

Available in adjustable and fixed proportional band models, and with three control forms . . . for flow, temperature, pressure, level and other process variables. Universal bracket permits optimum flexibility in mounting . . . coded, interchangeable sections and split manifold contribute to simplified maintenance. Write for Specification Sheet No. 768.

TEL-O-SET RECORDER

Features withdrawal of chassis for full 8-hour chart visibility without interrupting operations, bumpless shifting from automatic to manual operation, all adjustments from front of panel, built-in adjustable restrictions for pulsating flow . . . requires panel space just $5\frac{1}{16}$" high by 5" wide. Write for Specification Sheet No. 769.





TYPICAL ENGINEERED *TEL-O-SET* CONTROL SYSTEM—Pictured in this diagram are the elements of the *Tel-O-Set* Family, designed and built as an integrated loop. Here the system is applied to the control of flow with the *Differential Converter* used as transmitter.

TEL-O-SET INDICATOR

Can be used with any pneumatic transmitter, having a 3-15 psi controlled air output, regardless of the primary element being used. Provides indication of process variable, set-point of controller or controlled air pressure to valve when on automatic control . . . is easily shifted to manual operation. Panel cut-out size same as recorder. Write for Specification Sheet No. 770.

Contribution to Process Control

. . . THE HONEYWELL TEL-O-SET FAMILY

THIS pace-setting pneumatic control system is ready for application to a host of processes demanding a new high in speed, precision and accuracy . . . for almost any process variable. Developed as part of a family relationship, each unit complements the others in producing a system of superior performance.

Used with any one of a group of Honeywell measuring elements . . . for flow, temperature, pressure, liquid level, etc. . . . the *Tel-O-Set* system is destined to make important contributions to the improvement of process control throughout industry.

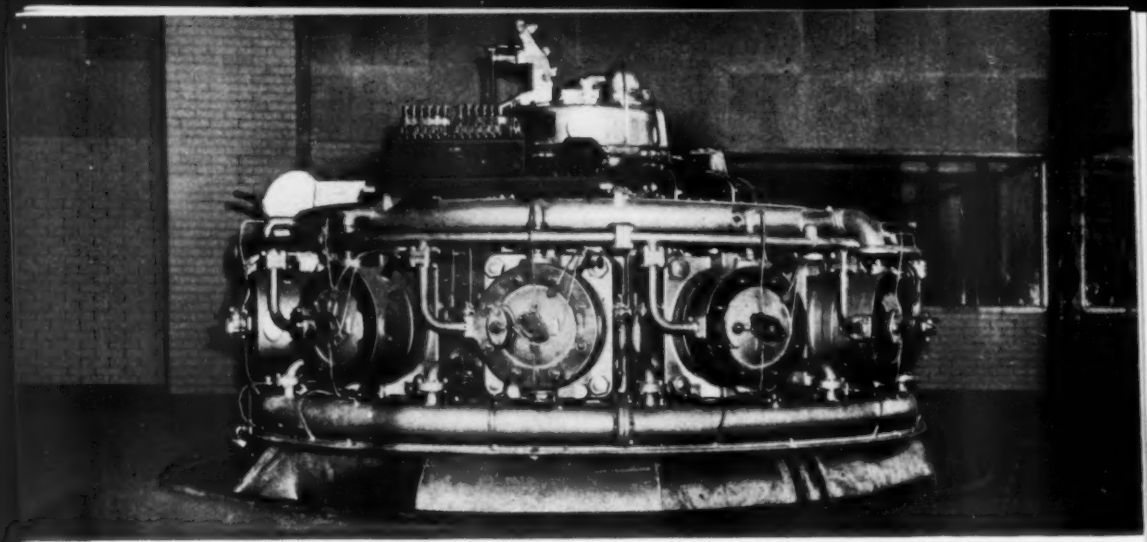
For more detailed information, send for the literature mentioned in the descriptions at left . . . or call in our local engineering representative for a discussion of your process control problems.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4488 Wayne Ave., Philadelphia 44, Pa.

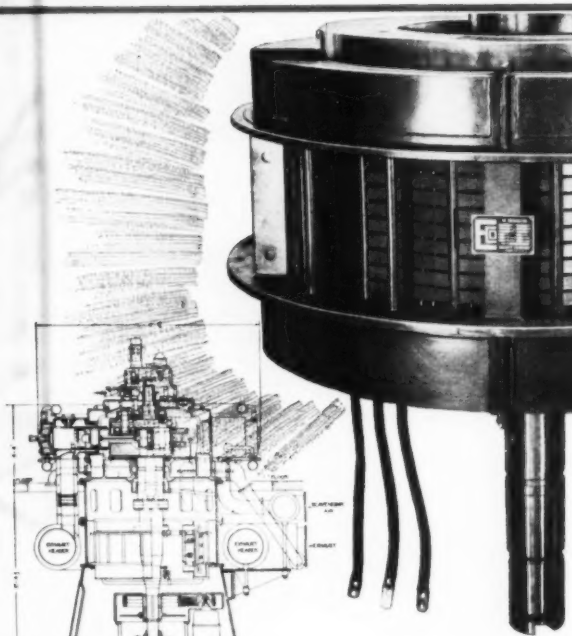
MINNEAPOLIS **Honeywell**

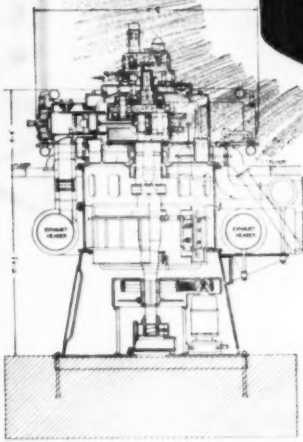
BROWN INSTRUMENTS

First in Controls



Another "FIRST" by ELLIOTT





First Commercial Radial Engine-Driven A. C. Generating Unit

Using only a fraction of the floor space required by a similar rated horizontal Diesel unit, this vertical installation is tops in compactness. The Elliott synchronous generator, rated at 1612 kva, 400 rpm, 2400 volts, has been specially designed so that the generator stator is housed within the engine base, eliminating the necessity for the stator wrapper, and conserving space. Further compactness is obtained by building extra mass into the generator rotor, eliminating the need for an engine flywheel.

Along with these features, all the flexibility and efficiency of Elliott "Fabri-Steel" design and construction have been maintained. The stator frame and rotor spider are of welded steel for strength and rigidity. The advantages of ample capacity, superior coil insulation and silver brazed electrical joints are likewise preserved.

Bulletin PB-2000-2 gives all the details. Write for a copy today.

J-722

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THE PARADE OF VALUES IN J&L
BLUE RIBBON INTEGRAL-JOINT DRILL PIPE
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FOUR
FIVE
Heat-treated Blue Ribbon Alloy Steel throughout the full length of the drill pipe. Blue Ribbon I-J Drill Pipe gets careful full length heat treatment involving normalizing and temper treatments to refine the grain structure of this patented air hardened steel.
Special alloy wear bands on the box end of the tool joint section provide maximum resistance to abrasion.
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Physical properties of J&L I-J Drill Pipe are uniformly high. Average yield strength—91,000 Psi, Minimum—80,000 Psi; Average tensile strength—116,000 Psi, Minimum—105,000 Psi; Elongation in 2"—Average—25%, Minimum—20%.
Only one offset along the inside of the tool joint means considerable reduction in mud turbulence at the joint—an efficiency factor that may be used in reducing mud pressure at pumps or to increase mud velocity at the bit.
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MORE SCRAP TODAY...
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And these are only a few of the advantages offered by J&L Blue Ribbon Integral-Joint Drill Pipe. Why not contact the J&L representative nearest you today? You'll find knowing all the facts about J&L I-J Drill Pipe efficiency pays in terms of lower drilling costs.
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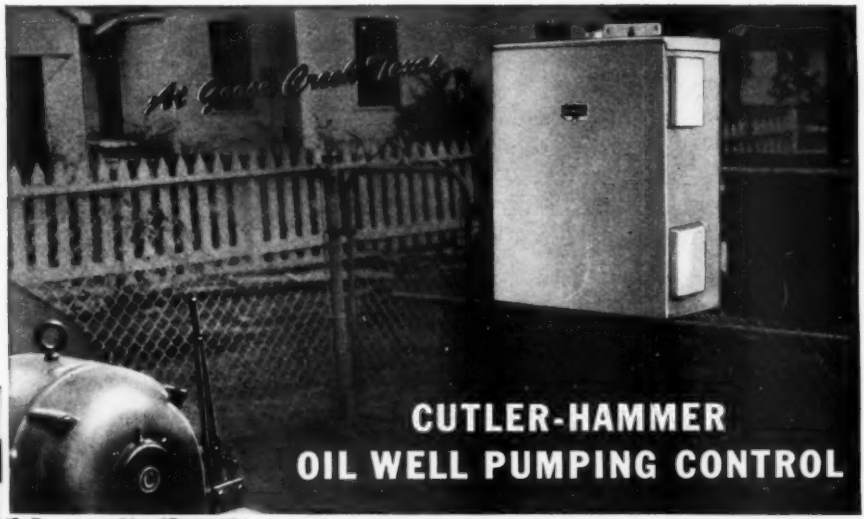
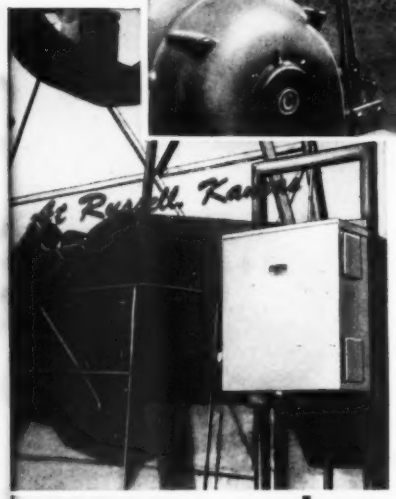
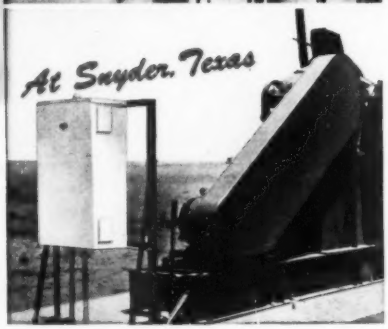


CUTLER-HAMMER OIL WELL PUMPING CONTROL





Built for the toughest conditions Right for any conditions

It can truthfully be said the Cutler-Hammer Oil Well Pumping Control has been designed and built in response to the practical operating needs of the oil country. It has been built to withstand climatic extremes . . . hot, dusty, insect and storm prevalent conditions . . . or salt-laden, hot, humid atmospheres. It has the "stuff" to stand up anywhere.

The controller case has 4 openings for *adequate* ventilation. The aluminum painted case reflects the sun's heat. You don't have to prop the door open to dirt and insects to keep this starter cool.

The ventilators are fine mesh screened, louvered and plate-guarded to keep out dirt, dust and bugs. The vertical contacts shed dust. The timer case is neoprene-gasketed and dustproof . . . the clock motor has extra power—keeps on running—dependably.

Unit type lightning arresters show their condition at a glance. If one blows, it's clean . . . you don't have to disassemble the starter to clean up afterwards. This control is available without undervoltage relay or *with* undervoltage relay, but the popular type with automatic staggered restarting requires no attention should power fail during a storm, because *proper* restarting is automatic in preset and adjustable intervals. Changes in pumping schedule are easy, accurate. Reset of timer clock is performed by turning a handy palm-sized dial. Wiring diagram with spare parts list and overload heater coil ratings is plastic-covered against grease, sweat, dirt, moisture and wear. These are but a few of the features that make the Cutler-Hammer Oil Well Pumping Control outstanding in the field. CUTLER-HAMMER, Inc., 1453 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

OTHER CUTLER-HAMMER PRODUCTS FOR THE INDUSTRY

Famous Cutler-Hammer UNITROL Control Center
Groups controls in one centralized, flexible housing. All parts interchangeable. Simplifies installation and wiring. Sections easily added. Simplifies servicing and insures better periodical inspection.

Bulletin 9586 Across the Line Starter
For standard or high torque polyphase squirrel cage motors. Famous features, *vertical* dust-safe contacts, eutectic alloy overload relay. Rugged construction, ample reserve. Dust-tight or water-tight enclosing case.

CUTLER-HAMMER
MOTOR CONTROL
C-H

DU PONT

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT

March ★ One of a Series of Interest to the Petroleum Industry ★ 1952

"New Look" for Du Pont Quarterly Motor Gasoline Survey

Just as gasolines are tailored to meet seasonal driving needs, the 1952 covers for Du Pont's Quarterly Motor Gasoline Surveys have been redesigned to portray the season in which they appear. This change is intended to make for quicker identification of any desired issues.

The January 1952 cover showed a snow-flaked winter service station scene. In the background was a map of the United States and Canada, indicating the extensive territory covered by the survey.

The April issue (due the week of April 21st) will carry out the seasonal theme with a spring scene.

Du Pont Historical Highlights

When the Du Pont Company was founded a century and a half ago, Federal Government income came almost entirely from customs duties. Taxes on the cost of manufacturing were almost unknown. Income, excess profits, franchise, sales, use, inheritance and social security taxes did not exist.

State taxes were levied chiefly on property and the State of Delaware's entire tax collection in 1802 amounted to less than $13,000 and total Federal income was $15 million.

Recent additions to the Du Pont Experimental Station alone cost more than $30 million, or twice as much as the entire Federal income in the year the Company was founded. And even the new Du Pont Petroleum Laboratory facilities would have taken a substantial bite from Uncle Sam's 1802 income if that gentleman had been required to pay the bill.

New Planning Staff will Coordinate Du Pont Facilities to Meet Petroleum Industry Needs

Because of the tremendous growth of the petroleum industry during the past decade, Du Pont is expanding its efforts to anticipate, as well as meet, the industry's petroleum chemicals requirements.

PLANNING MANAGER

T. BALDWIN PRICKETT was recently appointed Planning Manager of the Du Pont Petroleum Chemicals Division.

Mr. Prickett's previous activities and experience as refinery technologist for the division make him well qualified to take over his new duties of coordinating Du Pont's facilities to meet current and future needs of the petroleum industry.

His broad experience in chemical manufacturing includes work with the National Aniline and Chemical Company and the Pennsylvania Salt Manufacturing Company.

In 1931, Mr. Prickett joined Socony-Vacuum Oil Company and became assistant plant engineer in charge of initial development of the Houdry catalytic cracking process. He later became associated with the Houdry Process Corporation and affiliates as vice-president.

Just before he came to Du Pont in 1946, Mr. Prickett was in charge of commercial development of the Houdry process. He also directed the engineering, plant operations, and catalyst manufacturing activities of the Houdry Corporation.

To activate this program, the Du Pont Petroleum Chemicals Division recently organized a full-time planning staff.

Among the aims of this group will be long-range plans to assure ample supplies and convenient deliveries of all gasoline additives, plus the consideration of new product development to meet specific industry needs. These activities will complement the work of the Du Pont engineering laboratories and technical, automotive and other Du Pont petroleum industry service groups.

BROAD INDUSTRY STUDIES

To help keep the Du Pont Company informed on the growth and trends of the industry it serves, the planning group will base its studies not only on tetraethyl lead production, but on the broad foundation of all other factors contributing to supply and demand trends in the petroleum industry. Such a project calls for comprehensive studies of transportation facilities, technical refining developments and sources of supply for raw materials. Automotive and aviation engineering trends will be considered, too.

Although extremely broad in scope, the program is expected to result in many practical benefits for refiners. And, as the only manufacturer of a complete line of gasoline additives, Du Pont is keenly interested in continuing to serve the industry on as comprehensive a scale as possible.

To help accomplish the goal, the Du Pont Petroleum Chemicals Division is supported by research facilities that rank among the world's largest. Cooperating with these facilities on the development of new products to meet petroleum industry needs will be an important function of the new planning group. And the group will be constantly working to make Du Pont petroleum chemicals more exactly tailored to your specific refinery needs.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

PETROLEUM CHEMICALS DIVISION
NEWS

New Du Pont Book Helps Small Refineries Set Up Safety Programs

"How can we set up an effective safety program in our refinery?"

That was a question frequently asked Du Pont by refiners operating plants with up to 2,000 employees. With a long established safety history and a keen interest in furthering safety throughout industry, Du Pont is regarded as a logical source of help in safety planning.

As a result of many requests, Du Pont recently published "Safety for the Small Refinery"—a 42-page book prepared with the help and cooperation of the National Safety Council. It tells, step by step, how to set up an effective refinery safety program and, more important, how to use the wealth of safety material available to refiners.

MANAGEMENT FUNCTION

While the foreman is a key man in any good industrial safety program, safety is also an important *function* of *every* job. And most important of

all, the safety program must gain its driving force from the active participation and interest of top management.

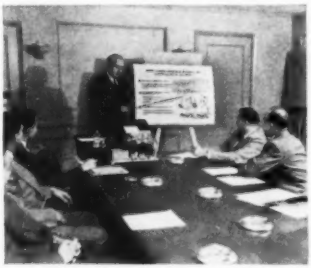
In this connection, the new Du Pont book outlines a basic safety philosophy around which refinery management can build its own policy. It also contains a suggested plan for setting up a refinery safety council of executives, and a safety committee drawn from plant personnel.

The book lists a wide range of general safety material available from the National Safety Council and the American Petroleum Institute. Typical monthly and yearly refinery safety programs are outlined in detail—on a day-by-day basis.

A copy of "Safety for the Small Refinery" is available to you through the nearest Du Pont Petroleum Chemicals Division district office.

DU PONT TANK CLEANING CLINIC GOES ON TOUR

Based on the request of a large oil company, the Operations Group of the Petroleum Chemicals Division has set up a discussion clinic on the hazards connected with entry of leaded storage tanks.



B. GARDNER CRANE, Director of the Du Pont Petroleum Chemicals Division Operations Group, conducting a typical refinery safety clinic.

Headed by B. Gardner Crane who directs the Du Pont Operations Group and Dr. Stewart L. Rankin, chief medical advisor to the Petroleum Chemicals Division, the clinic recently completed a tour of five refineries operated by the company requesting the service. The meetings met with enthusiastic approval, and the Operations Group is now prepared to take the clinic on tour for other refiners interested in the service.

Essentially, the clinic is a safety review program for terminal managers and group leaders directly concerned with tank cleaning. Informal, yet broad in scope, it discusses the main problems and precautions involved in cleaning leaded storage tanks.

COMPREHENSIVE PROGRAM

Basically, the clinic program covers the following:

1. Toxicity of tetraethyl lead compounds.
2. Order of magnitude of TEL hazards in leaded gasoline storage tanks.
3. Description of lead-free tank for purpose of entry without protective equipment . . . for both "cold" and "hot" work. The exceptions are also covered.
4. The mechanics of tank cleaning, including sludge disposal problems.
5. Description of use and limitations of Du Pont Lead-in-Air Analyzer.
6. Emergencies in handling tetraethyl lead compounds.
7. Question and answer session.

The program is quite flexible and can be readily varied to meet individual plant or company needs.

For information regarding the Du Pont Tank Cleaning Clinic, get in touch with your Du Pont Petroleum Chemicals Division district office.

Literature—Movies Available

Here is a partial listing of the movies, bulletins, reports, booklets and aids available to you through the nearest Du Pont Petroleum Chemicals Division district office:

Safety for the Small Refinery – A 42-page book on how to set up an effective small refinery safety program . . . . . Serial A-2848

Tank Talk – A 52-page, easy-to-understand safety booklet for tank-cleaning crews Serial A-1134

Prints of the following Du Pont films are available to oil companies for training and public relations purposes. They may be borrowed or purchased.

Pipeline on Wheels – A 26-minute, full-color movie on tank truck safety. Suitable for both training and public relations purposes.

What makes a Gasoline Good – An 18-minute cartoon movie in color. Presents, in easy-to-understand form, the story of how high quality gasoline is made. Ideal for dealer training meetings.

In addition, Du Pont makes available a special library of films of particular interest to the petroleum industry.

DU PONT

Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
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PHILADELPHIA SPIRAL-BEVEL COOLING TOWER DRIVE

The growing use of larger fans in cooling tower service brought the need for a drive that would best meet heavier load conditions. Philadelphia, having long been a leading manufacturer of conventional worm gear cooling tower drives, thoroughly understood this problem.

Our solution: an entirely new spiral bevel-helical drive.

This new unit is extremely compact, yet sturdy of construction. Units available in a wide range of sizes and ratios.

For assurance of dependable operation, long life and high load transmission specify a Philadelphia drive.

Design and construction features are in Bulletin CT-51. Write for a copy on your business letterhead.

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Industrial Gears and Speed Reducers
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ATTAPULGUS Fullers Earth
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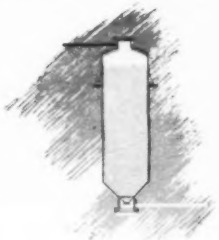
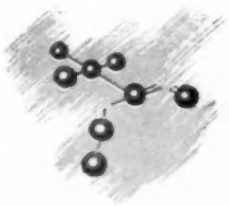
WHAT DO YOU WANT TO PURIFY?

There's an Attapulgus or Porocel adsorbent to fit your process technique for removing odors, colors, tastes, moisture, acids, sulfur, fluorides and unsaturates from process liquids or gases. Materials treated in principal applications are: motor oils and other lubricating, specialty, and technical oils; petrolatums and waxes; aviation and motor gasoline stocks; kerosene; diesel and heating oils.



DO YOU HAVE CATALYST OR CATALYST CARRIER NEEDS?

Attapulgus or Porocel sorptive minerals are recognized standards in desulfurization, reforming and isomerization systems—catalytic removal of unsaturates—conversion of sulfides to elemental sulfur—fluid catalyst applications—as catalyst carrier in copper sweetening processes.



WHAT DO YOU WANT TO DRY?

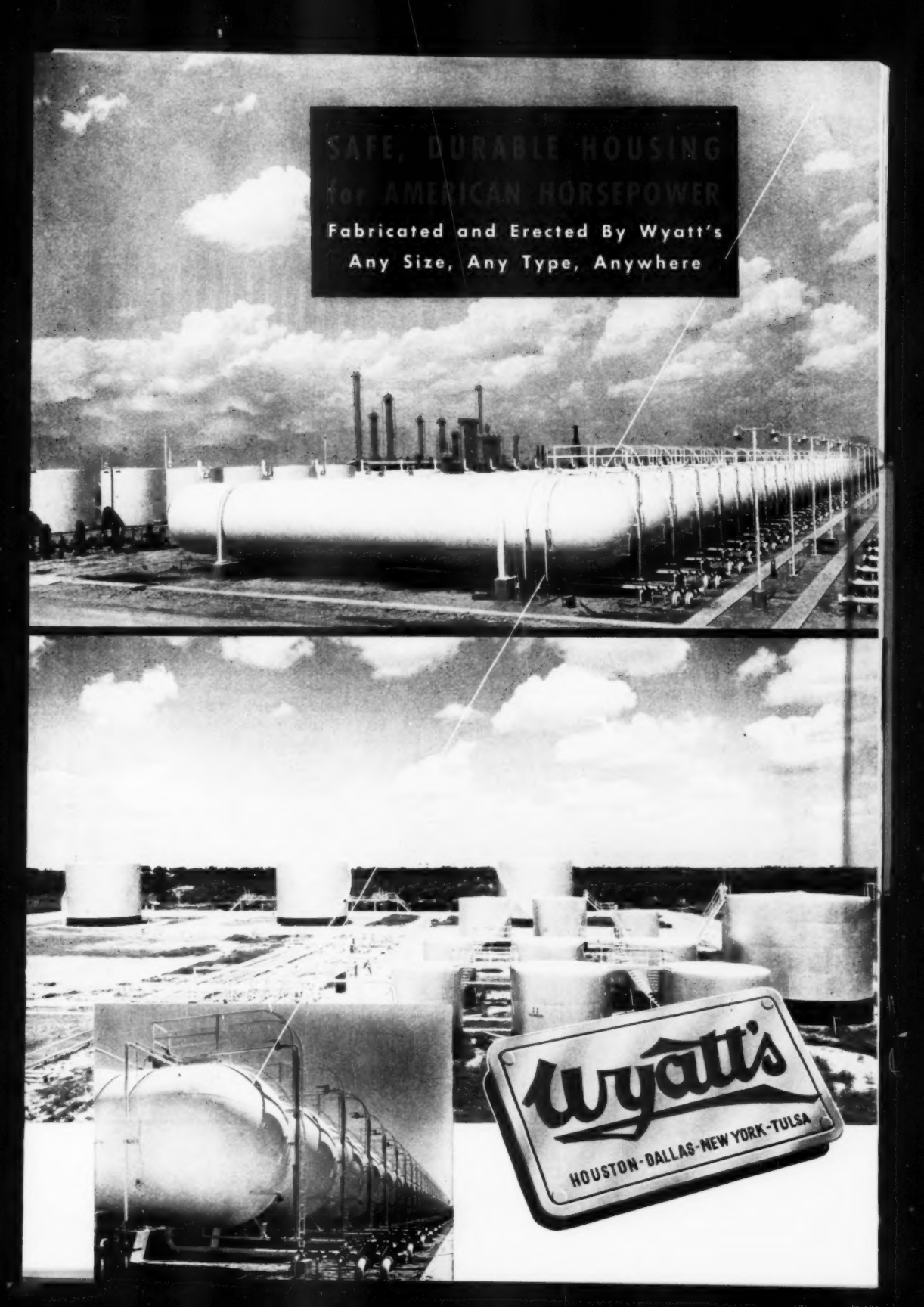
We offer a wide range of reliable, thoroughly proved desiccants for drying air, hydrogen, carbon dioxide, hydrocarbon liquids and gases.

SPECIAL GRADES?

Mine and plant facilities permit prompt and economical production of grades meeting individual customer specifications. Our laboratories and technical staffs welcome the opportunity of assisting in research, development, design and operating problems. Your inquiries are invited.

ATTAPULGUS CLAY COMPANY *Fullers Earth* • **POROCEL CORPORATION** *Activated Bauxites*

Dept. V, 210 West Washington Square, Philadelphia 5, Pa.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Fabricated and Erected By Wyatt's
Any Size, Any Type, Anywhere
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Boost Pipeline Throughput ...and Cut Cost!

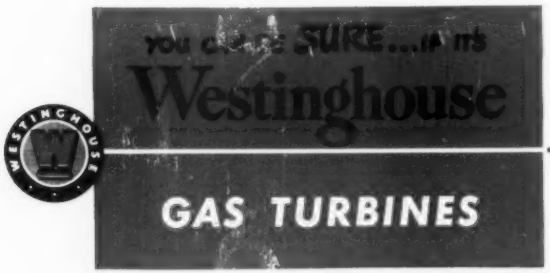
Of growing interest to pipeline operators is the possibility of increasing pipeline capacity through the use of gas-turbine-driven centrifugal compressors, thus conserving the steel that might otherwise be required for looping. By the use of low-compression-ratio intermediate booster stations, line pressure is more closely sustained, giving maximum flow with minimum energy input; and the need for cooling water and heat-exchange systems to cool the gas is eliminated.

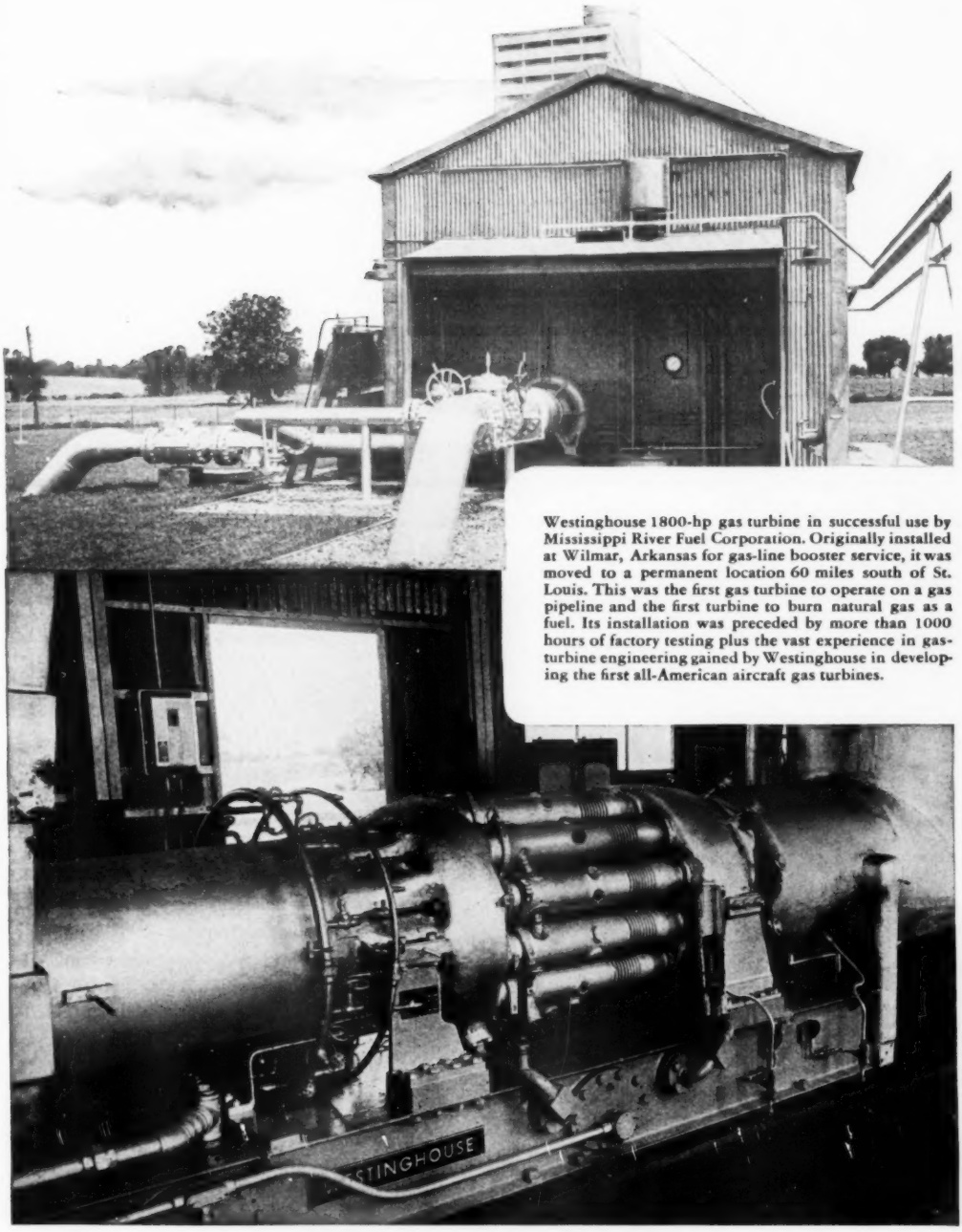
The gas turbine is simple, compact, and economical. It puts out more power per pound of weight than any other industrial power plant. Installed cost is ⅓ to ½ less, per horsepower, than for reciprocating pumping units. It is readily moved into remote, undeveloped regions, and is easily set up. It requires a minimum-cost building; and its only foundation is a 2-foot concrete slab the size of the bedplate. It requires no water, and no power for starting or for auxiliaries. It has few moving parts. It requires a minimum of lubricating oil, and maintenance is negligible. It is easily adapted for remote control of several stations from one supervisory location, and is provided with safety features that permit unattended operation.

Westinghouse now offers the pipeline industry . . .

- an 1800-hp, single-shaft, simple open-cycle, non-regenerative gas turbine, operating at 8750 rpm, with an efficiency of 17.5% at the turbine coupling.
- a 5000-hp, dual-shaft, compound, open-cycle, regenerative gas turbine, operating at 6500 rpm, with an efficiency of 25.0% at the turbine coupling.
- a 6500-hp, single-shaft, simple open-cycle, non-regenerative gas turbine, operating at 5700 rpm, with an efficiency of 21.0% at the turbine coupling.

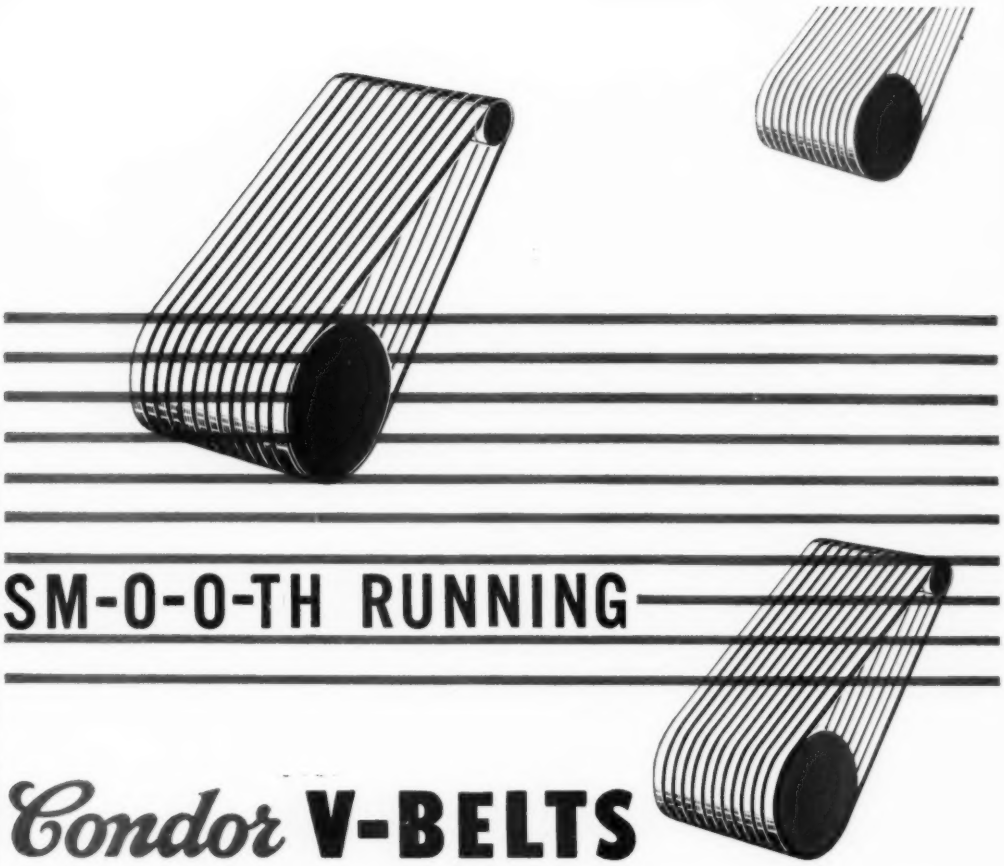
Get the full story on this important cost-cutting development from your nearby Westinghouse Application Engineer, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-50534





Westinghouse 1800-hp gas turbine in successful use by Mississippi River Fuel Corporation. Originally installed at Wilmar, Arkansas for gas-line booster service, it was moved to a permanent location 60 miles south of St. Louis. This was the first gas turbine to operate on a gas pipeline and the first turbine to burn natural gas as a fuel. Its installation was preceded by more than 1000 hours of factory testing plus the vast experience in gas-turbine engineering gained by Westinghouse in developing the first all-American aircraft gas turbines.

1800 H. P. GAS TURBINE



SM-O-O-TH RUNNING

Condor V-BELTS

You get long belt life and low belt costs with Condor V-Belts because they are the smoothest running V-belts made. These are the Raybestos-Manhattan engineering reasons . . . Pulling section is micro-positioned, where engineering says it should be . . . Straight sidewalls give more grip, less slip, longer life . . . Every part of belt is precision-balanced. Other advantages are described in Bulletin 6868D. Write for a copy . . . or call your R/M Distributor • We can show you also how equally good engineering in R/M hose, conveyor and transmission belts helps "smooth out" production problems.

R/M

MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY

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Other R/M products include: Industrial Rubber • Fan Belts • Radiator Hose • Packings • Brake Linings • Brake Blocks Clutch Facings • Asbestos Textiles • Sintered Metal Parts • Bowling Balls

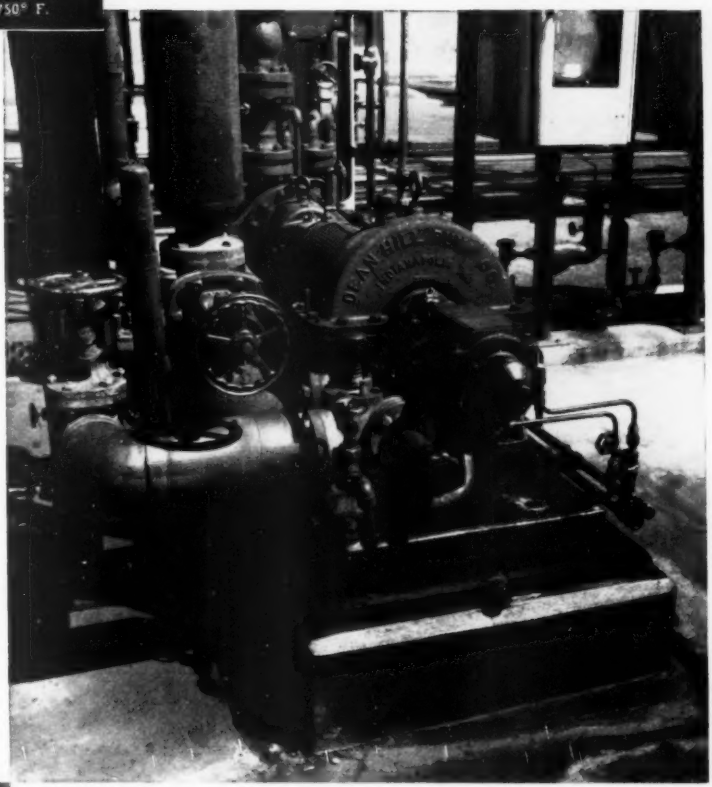
Designed with the operator in mind!

HORSEPOWER UP TO 1000
PRESSURES UP TO 875 LBS.-750° F.

No streamline housings.
No needless cover-ups.
Nothing fancy or frilly about these power-making huskies. Dean Hill Steam Turbines are designed and built for nothing but long service and easy, economical operation. Their heavy, rugged construction is simple and uncluttered for quick, easy maintenance. All pressure parts are outside and visible to operator.

DEAN HILL STEAM TURBINES

.....are single stage, double impact type for low steam consumption. Specifically designed for operation at medium steam pressures and temperatures, DH Turbines have all the advantages available under these conditions, including excellent water rates. Write us for further information and complete specifications.



One of eighty-four Dean Hill Steam Turbines recently installed in a large, eastern Refinery

DEAN HILL PUMP COMPANY

Pump and Turbine Engineers Since 1895

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On your low-bed trailers, get two independent braking systems plus precision synchronization for

SAFE STRAIGHT-LINE BRAKING

With Warner *Electric* Brakes on your low-bed trailers you have a *double* measure of safety.

For, Warner *Electric* Brakes provide an independent trailer braking system which synchronizes with tractor brakes. This dual braking system means *double* safety factor!

Warner *Electric* Brakes give you *precision synchronization* for balanced braking . . . instantaneous, uniform braking of *all* wheels on both the tractor and trailer. No time lag in the action . . . braking power is applied with the speed of electricity for split-second performance . . . lets the driver apply and release braking power exactly as he needs it to match every traffic or road condition.

Precisely synchronized Warner *electric* braking action means smooth, *straight-line* deceleration and stops.

Tractor and trailer act as a single unit to guard against skidding, diving, sliding and jack-knifing . . . to bring your drivers a new high in braking safety. Send for new folder "Six Steps to Better Braking for Truck Trailers"

OUR 25TH YEAR—WARNER ELECTRIC BRAKE & CLUTCH COMPANY, BELOIT, WISCONSIN

WARNER

ELECTRIC BRAKES

FOR TRUCK TRAILERS

HERE'S HOW ELECTRIC

"WARNER WAY"... all brakes reach full power together to keep tractor and trailer in line . . . safe, straight-line braking for gradual or emergency stops.

PHOTO COURTESY OF NORTHERN INDIANA PUBLIC SERVICE COMPANY

Electric brakes now available for all types of low-bed trailer operation

Warner Electric Brakes are specially engineered for use on all types of low-bed trailers.

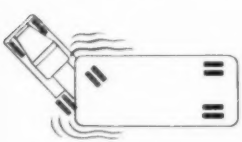
They are available in these sizes: 12¼" x 5½", 15" x 3" and 16½" x 5", 6", 7".

Thus, you are sure of being able to enjoy the advantages of Warner *Electric* Braking on whatever type of low-bed trailer you need for your specific operations.

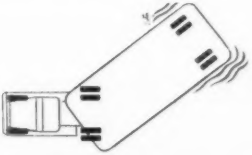
And, remember, with Warner *Electric* Brakes you have *full clearance* under the trailer. Nothing protrudes or hangs down to catch on rocks, ruts, other obstructions . . . there is nothing exposed to get knocked off or leak.

In all, Warner Electric Brakes are the ideal braking system for low-bed trailers . . . for simplicity of operation, for two independent braking systems and for assured safe *straight-line* braking!

RAKES PROTECT AGAINST JACK-KNIFING



WRONG WAY . . . when brakes aren't synchronized and tractor brakes "come in" ahead . . . jack-knife is sudden, drive wheels slide sharply. Recovery is difficult.

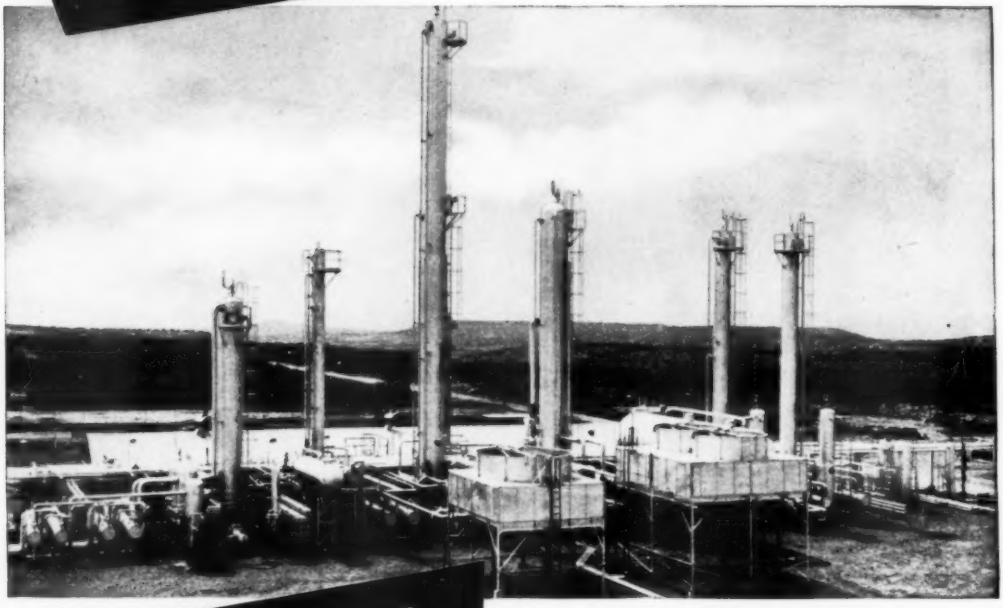


WRONG WAY . . . when brakes aren't synchronized and trailer brakes "build up" first . . . rear of trailer swings, then comes around into a jack-knife.

FREE! **NEW FACTUAL FOLDER "SIX STEPS TO BETTER BRAKING FOR TRUCK TRAILERS." GET YOUR COPY NOW.**

Gives important tips on driver safety through synchronized braking. Explains the precise operation, simplicity of hook-up, amazing economy and added safety features of *electric* braking. Write today. Warner Electric Brake & Clutch Company, Dept. OGJ, Beloit, Wisconsin.

Reduce Fouling in your plant



with BROWN FINTUBE *sectional hairpin heat exchangers*

● Brown Sectional Heat Exchangers, with their integral one-piece extended surface fintubes, reduce fouling, just a few hundredths of an inch of which on a tube causes a major loss in heat transfer efficiency.

These exchangers assure efficient operation at low "skin" temperatures, minimizing coking and building up on the fintubes. And the controlled flow through the longitudinal passages keeps all the material in continuous motion. There are no baffles, back-eddies or stagnant areas to encourage fouling.

For top operating efficiency and reduced fouling use Brown Sectional Heat Exchangers throughout your plant. ***Write for Bulletin No. 481.***

THE BROWN FINTUBE CO.

Elyria, Ohio

Sectional Hairpin Heat Exchangers
Tank Suction and Line Heaters
Fintube Heaters for Bulk Storage Tanks
Indirect Process Air Heaters
Fintube Heaters for Processing Tanks
Integrally Welded Fintubes for Any Heating, Cooling or Heat Transfer Service

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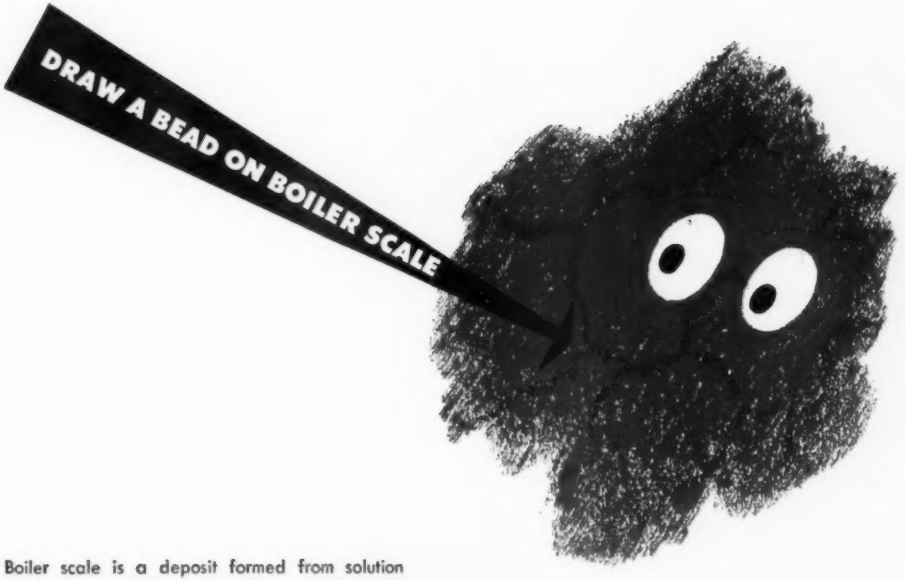

Boiler scale is a deposit formed from solution directly in place upon a confining surface. It is crystalline and dense and usually retains its physical shape when removed. (Ref. ASTM D 887, D 933).

Use DREW POWER CHEMICALS

No boiler is exempt from scale under present day operating conditions. Scale results in tube failure, plant shut-down, trouble and inconvenience. It's the duty of every good water treatment company to recognize and solve this problem.

Draw a bead on boiler scale! Call in the Drew Engineer. The water samples and operating data that he obtains in your plant will be thoroughly analyzed in the Drew Laboratories, and you'll be given specific recommendations for corrective or preventive treatment. And you'll receive frequent and continous service, too.

Thorough investigation, proper treatment and frequent service have made Drew one of America's fastest growing water treatment companies. Consult the nearest Drew engineer or write for information

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Nationwide Service in Boiler Water and Cooling Water Conditioning

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CHASE ANTIMONIAL ADMIRALTY *(A patented alloy)*

If you want heat exchanger tubes that will stand up for years under tough conditions, remember... Chase Antimonial Admiralty* Heat Exchanger Tubes last longer! It's the antimony that does it!

These great heat exchanger tubes have enough antimony to resist dezincification. And antimony will not weaken the tube. The metal starts with the right grain structure and retains it... it stays tough and withstands the stresses of heavy duty assignments.

You'll do better with Chase Antimonial Admiralty Heat Exchanger Tubes! Send coupon for FREE Book.

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FREE CHASE BOOK discusses corrosion problems and selection of proper alloy for condenser and heat exchanger tubes.

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Waterbury 20, Conn.
Please send me your free book on Condenser and Heat Exchanger Tubes.

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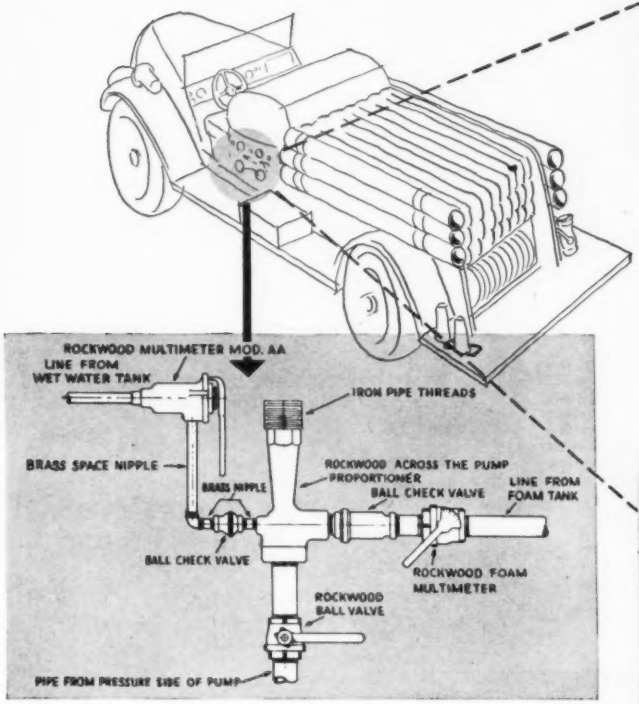
Chicago	Detroit	Milwaukee	Philadelphia	San Francisco	

Flaming Liquids Stop Short! Water Goes Farther!

. . . with Rockwood's action-proved fire fighting aids.



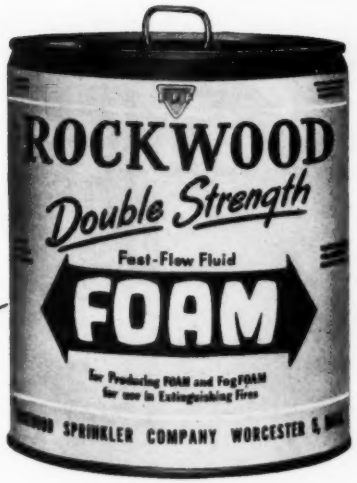
ACCURATE MIXING ASSURED. Automatically feeding FOAM or WET Liquids into hose lines, Rockwood's Model Dual "B" Around-the-Pump Proportioner is designed for use where pressure is maintained by a pump from either draft supply or booster tank. Multimeter settings admit proper amounts of wetting agent for varying nozzle discharges and solution strengths.

A proportioning system to meet YOUR needs.

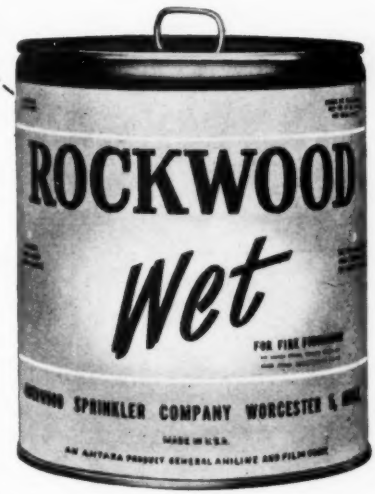
Different types of fires call for different proportioning systems for large-volume FOAM or WET discharge. Rockwood specializes in custom-engineered proportioning systems to meet particular needs, for all mobile equipment. Write for details.

GET THE FACTS on Rockwood's complete line of cost-cutting, efficiency-boosting products for modern fire fighting. Send for your copy of this big, illustrated catalog today.

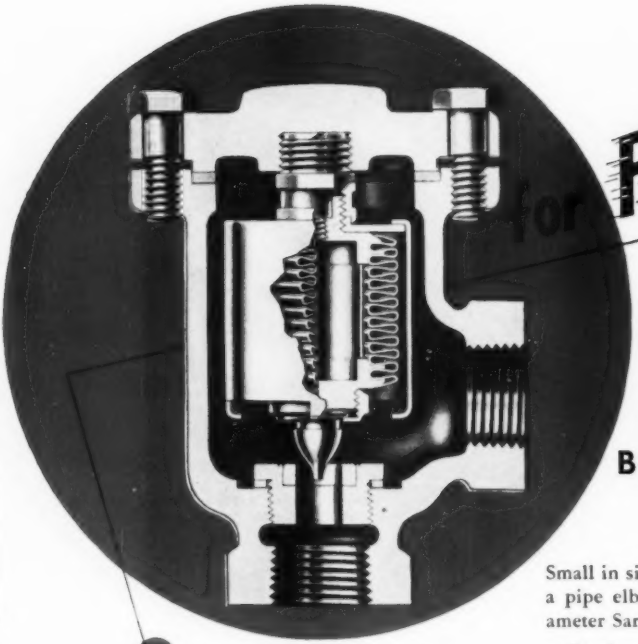
ROCKWOOD SPRINKLER CO.
104 Harlow Street, Worcester 5, Mass.
PORTABLE FIRE PROTECTION DIVISION



TO PUT OUT FIRES IN FLAMMABLE LIQUIDS FASTER AND AT LOWER COST, use Rockwood's new Double Strength FOAM Liquid. Three parts of FOAM Liquid mixed with 97 parts of water form an excellent foam blanket that will quickly re-seal if broken. This foam blanket has proved its ability to extinguish large spill fires in gasoline with maximum speed and safety to firemen. Double Strength FOAM Liquid is more fluid, faster spreading and flows freely at sub-zero temperatures (—15°F.). Rockwood Regular FOAM Liquid is also available for use with Rockwood devices.



TO MAKE A LITTLE WATER GO A LONG WAY, use Rockwood WET, a wetting agent prepared especially for fire fighting. WET speeds the spread and penetration of water into deep seated fires in such ordinary combustibles as wood, paper, cloth, etc. Thoroughly tested in action, a mixture of 1 part WET to 99 parts of water will help reduce the time, manpower and quantity of water needed to put out the stubbornest fires. WET retains its remarkable penetrating quality even at fire temperatures.



for **FAST ACTION**

use

SARCO

BALANCED PRESSURE THERMOSTATIC STEAM TRAPS

Small in size; light in weight, as easy to install as a pipe elbow, these new traps employ large diameter Sarco bellows proportioned to trap size.

Condensate only a few degrees below steam temperature snaps the large valve wide open. That means rapid and complete venting of air and non-condensables.

It means also exceptionally large condensate capacities.

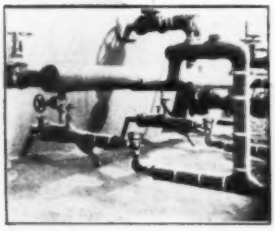
Actually the balanced pressure type thermostatic trap has the highest discharge capacity per dollar cost.

Other advantages: no seats to change when pressures change (fewer spares to carry); requires no protection against freezing.

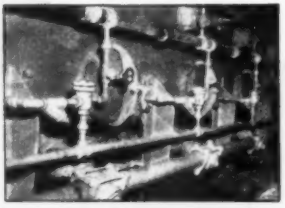
Sarco Thermostatic Steam Trap No. 9, available in sizes ½" to 2" for pressures to 300 psi. Bellows are phosphor bronze, monel or stainless steel as required, shielded from abrasion. Renewable valve heads and seats are of stainless steel.

WRITE for free copy of new catalog 256

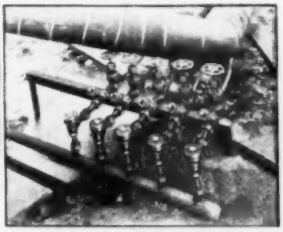
355



Sarco No. 9-225 traps and strainers draining steam heating coils in crude oil storage tanks.



Sarco No. 9-125 traps and strainers on bottle washer in brewery.



Sarco No. 9-300 traps and strainers removing air and condensate from steam tracer lines maintaining asphalt to storage tanks at pumping temperature.

SARCO COMPANY, INC.

EMPIRE STATE BUILDING, NEW YORK 1, N. Y.

SARCO CANADA LTD., TORONTO 5, ONTARIO

REPRESENTED IN PRINCIPAL CITIES

How Barrett* Coal-Tar Enamels
Cut Pipe-Protection Costs
BY THE YEAR ...BY THE MILE
10 REASONS WHY
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2. Barrett Coal-Tar Enamels withstand extremely high, extremely low atmospheric temperatures.
3. They have high ductility and flexibility.
4. Barrett coatings are highly resistant to soil stresses.
5. High dielectric properties.
6. Impermeable to moisture.
7. Resistant to attack by gas and petroleum products.
8. Easily available, easy to apply.
9. Barrett engineering service always available.
10. Prompt, dependable deliveries.
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Annual Meeting, Galveston, Tex., March 10-14
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THE BARRETT DIVISION
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New 24" line of Northeastern Gas Transmission Co. is protected with Barrett Pipeline Primer and 190° Pipeline Enamel.

Here is a magneto that controls explosive fumes with "flame-proof" ventilation. The special ventilating arrangement of the Bendix Low-Tension Magneto permits air laden with explosive fumes to enter the magneto for ventilation without danger of igniting the surrounding air. Kits are also available to convert magnetos now in use to the "flame-proof" ventilation type.

In addition to this important safety feature Bendix Low-Tension Magnetos actually reduce engine maintenance and operating costs. For example, spark plug erosion is reduced to a minimum. The distribution of low tension voltage to the high tension coils is through a series of breaker assemblies, thus eliminating trouble often experienced with the conventional distributor. Variable or fixed sparks can be obtained by internal adjustment.

For safety and low operating costs it will pay you to specify Bendix Low-Tension for all your magneto requirements. Complete data available on request.

- **Low Plug Erosion Rate**
- **Breaker Type Distributor**
- **Ventilation without Fire Hazard**
- **Radio Shielding Available**
- **Variable or Fixed Ignition**

Bendix

SCINTILLA MAGNETO DIVISION OF
SIDNEY, NEW YORK

Bendix AVIATION CORPORATION

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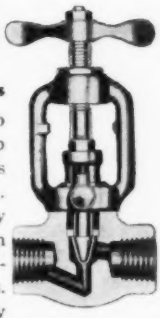
LOOK INTO *Edward* FORGED STEEL VALVES

For Design Features That Keep Costs LOW—Performance HIGH

Edward
INSTRUMENT VALVES

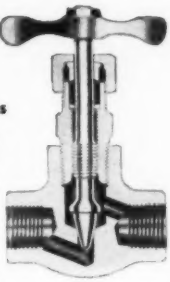
Fig. 952-3 Series



Ratings of 6000 lb WOG or 1500 lb sp at 1000 F, in sizes ¼ in. through 1 in. A compact, heavy duty valve with many extraordinary features. Drop forged body and yoke. Tapered 13% chromium stainless steel needle-type integral or swivel stem-disk. O. S. & Y. No bonnet joint—swing bolted gland. Screwed or socket welding ends—globe and angle types. Carbon steel or 13% chromium stainless steel body.

Edward
GAGE VALVES

Fig. 152-3 Series



Ratings of 4000 lb WOG or 600 lb sp at 750F, in sizes ⅛ in. through 1 in. Has special tapered body-bonnet thread joint in ⅛, ¾ and 1½ in. sizes so bonnet remains tight. Union bonnet in ¾ and 1 in. sizes. Carbon, 13% chrome or 18-8 stainless forged steel body—13% chrome stainless steel semi-needle disk. Female outlets and female and male inlets. Globe and angle types.

EDWARD STOP VALVES

Forged steel. 600 and 1500 lb sp at 850F or 2000 and 3600 lb at 100F respectively. Globe and angle. Bolted or union bonnet. Screwed or socket welding ends. Stop, needle or stop-check types. Sizes ¼ to 2 inch inclusive.

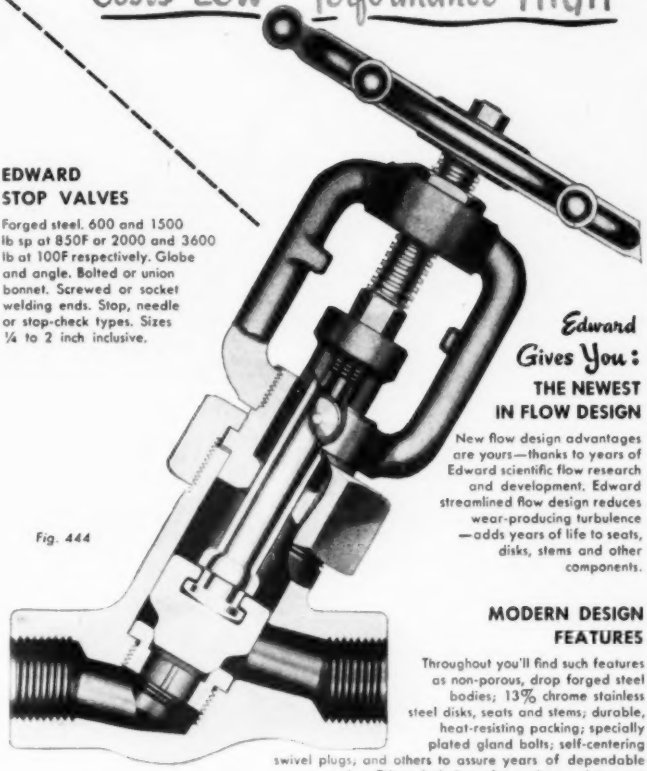


Fig. 444

Edward Gives You:

THE NEWEST IN FLOW DESIGN

New flow design advantages are yours—thanks to years of Edward scientific flow research and development. Edward streamlined flow design reduces wear-producing turbulence—adds years of life to seats, disks, stems and other components.

MODERN DESIGN FEATURES

Throughout you'll find such features as non-porous, drop forged steel bodies; 13% chrome stainless steel disks, seats and stems; durable, heat-resisting packing; specially plated gland bolts; self-centering swivel plugs; and others to assure years of dependable service. Edward design also makes maintenance and accessibility to parts simple and foolproof. Write for catalog.

A Product of Edward Valves, Inc., 1492 West 145th Street, East Chicago, Ind.

YOU NEED THIS!

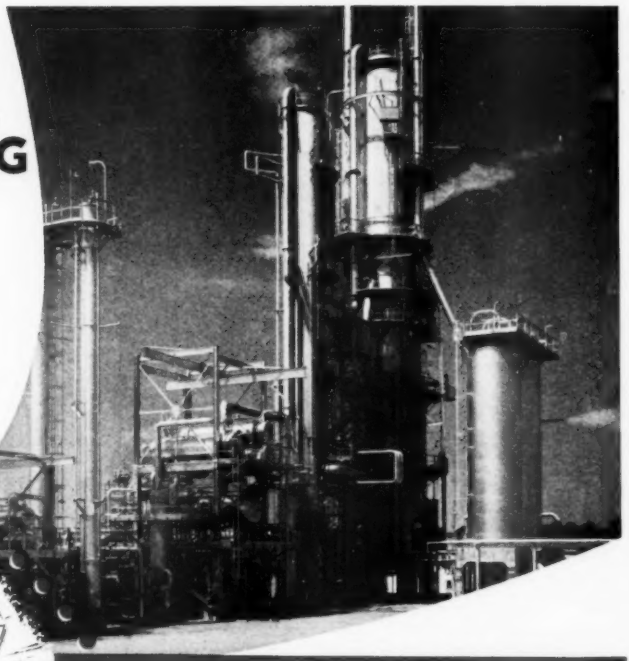
FOR COMPLETE INFORMATION on all Edward Steel Valves, write to Edward, Department CP, for 28 page comprehensive catalog #104, there's no obligation, of course.

Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

EAST CHICAGO, INDIANA

From DRAFTING TABLE to COMPLETED REFINERY TRECO GIVES YOU . . . .



GREATEST ECONOMY and MAXIMUM EFFICIENCY

If your problem involves the remodeling of an old plant or the building of a complete new one . . . your first step should be to wire, write or telephone Treco. You'll get fast action without obligation.

Maximum efficiency and greatest economy are not just words from a dictionary. They are the culmination of years of experience — a closely-integrated organization capable of designing, engineering and constructing a refinery to best fit your present needs and projected future requirements. Even under today's problems of decreasing labor supply and the increasing difficulty of securing materials and equipment, Treco has been able to complete all jobs within the contractural requirements.

TRECO

REFINERY ENGINEERING Company

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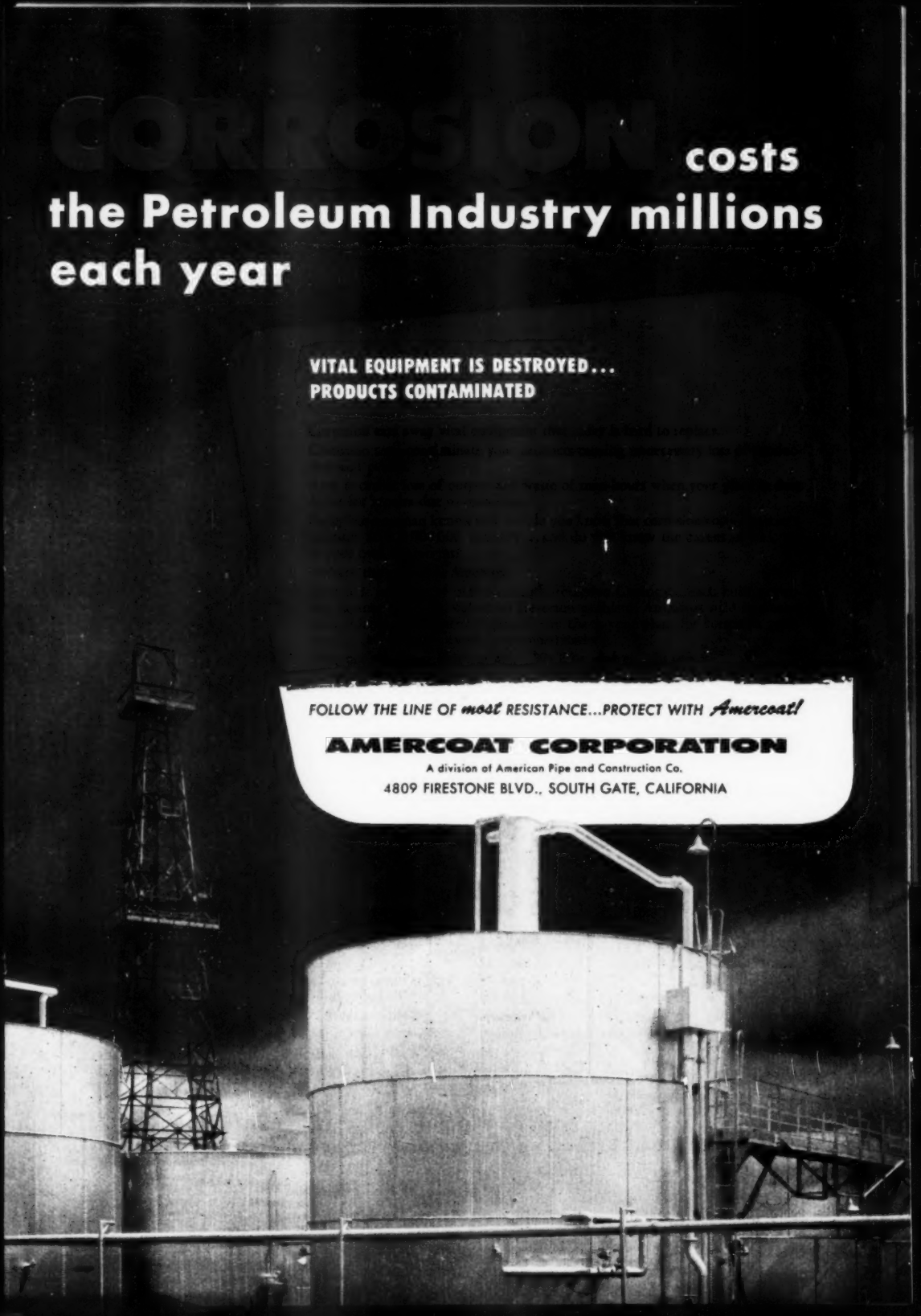
CORROSION costs
the Petroleum Industry millions
each year
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PRODUCTS CONTAMINATED
FOLLOW THE LINE OF most RESISTANCE...PROTECT WITH Amercoat!
AMERCOAT CORPORATION
A division of American Pipe and Construction Co.
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Now, say FLEXON

when you specify expansion joints for piping

Free-flexing units in stainless steel or copper for pressures to 30 psi; sizes to 48" I.D.
Controlled-flexing units in stainless steel or copper for pressures to 300 psi; sizes to 48" I.D.
Integral ring units in stainless steel for pressures to 5500 psi; temperatures to 1600° F; sizes to 6" I.D.

WITH the change of our corporate name from Chicago Metal Hose Corporation to FLEXONICS Corporation, CMH Expansion Joints are now known as FLEXON Expansion Joints. Just as the corporate name was changed to better describe the company's manufacturing activities, the name FLEXON should allow easier identification of these units.

Wherever motion is encountered in piping, the problem can be solved with FLEXON Expansion Joints. These dependable units are easily installed in new or existing lines and require only slightly more space than straight pipe. They cannot leak and require no maintenance.

Write for our new Expansion Joint "Design Guide". And remember, when you specify expansion joints, you now say, "FLEXON".

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EXPANSION JOINT DIVISION
1345 S. THIRD AVENUE · MAYWOOD, ILLINOIS

FORMERLY CHICAGO METAL HOSE CORPORATION

Flexon identifies products of Flexonics Corporation that have served industry for over 50 years.

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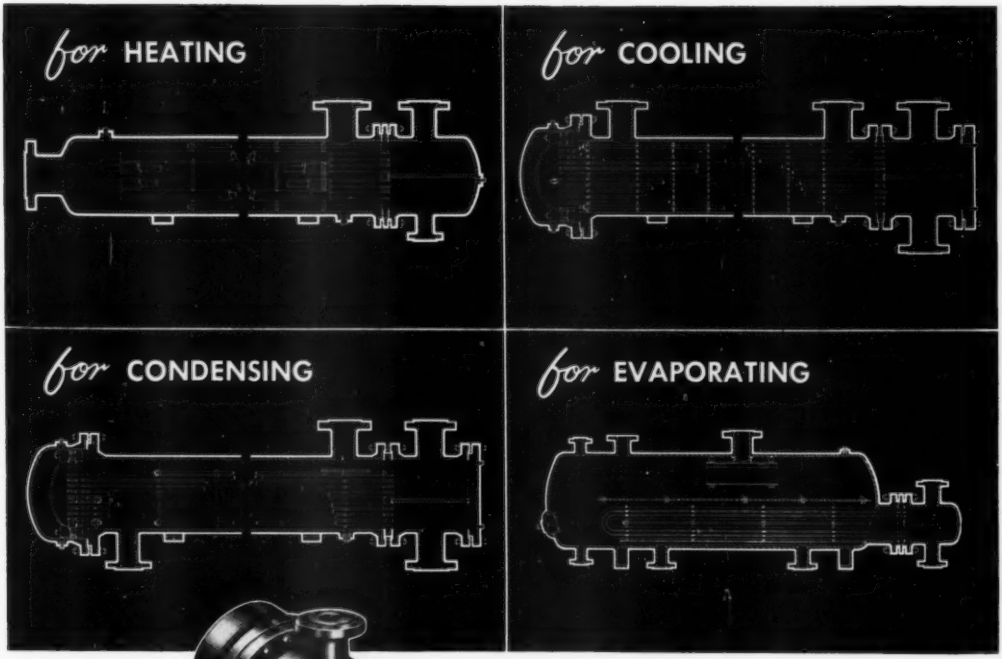
In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario



for EVERY Heat Transfer application

. . . SUPERIOR HEAT EXCHANGERS meet the widest possible range of application. They find their greatest use in power plants, oil refineries, chemical processing and industrial plants. Superior's basic components . . . heads, shells, and tube bundles . . . make possible combinations to meet the requirements of any heat transfer application.

Our engineering staff invites your inquiry regarding any proposed application . . . as a basis for a specific engineering recommendation. Write for catalog 520.

for performance you can **BANK** *on*

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SUPERIOR COMBUSTION INDUSTRIES INC.
TIMES TOWER, TIMES SQUARE, NEW YORK 18, N.Y.

FUELING... for fun or a fight

At the schoolground or in the stratosphere, flying takes fuel... whether it's only a thimbleful for a model or a tanker load for a Stratojet. Despite the difference in fuels, both may have come from the same oil well. Transforming crude into such varied types of fuel is a miracle worked by the petroleum industry... with an assist from chemistry.

Closely associated with the petroleum industry, Mathieson — now in its 60th year as one of America's major chemical companies — today supplies petroleum processors with more basic chemicals than ever before... such products as caustic soda, ammonia, sodium chlorite, sulphuric acid, diethylene glycol, triethylene glycol, dichloroethyl ether.

Currently, with market conditions uncertain, a dependable source of supply is especially important. If your production requires one or more of these chemicals, you may be able to buy *to better advantage* by consulting with us now. Mathieson Chemical Corporation, Baltimore 3, Maryland.

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CHEMICALS

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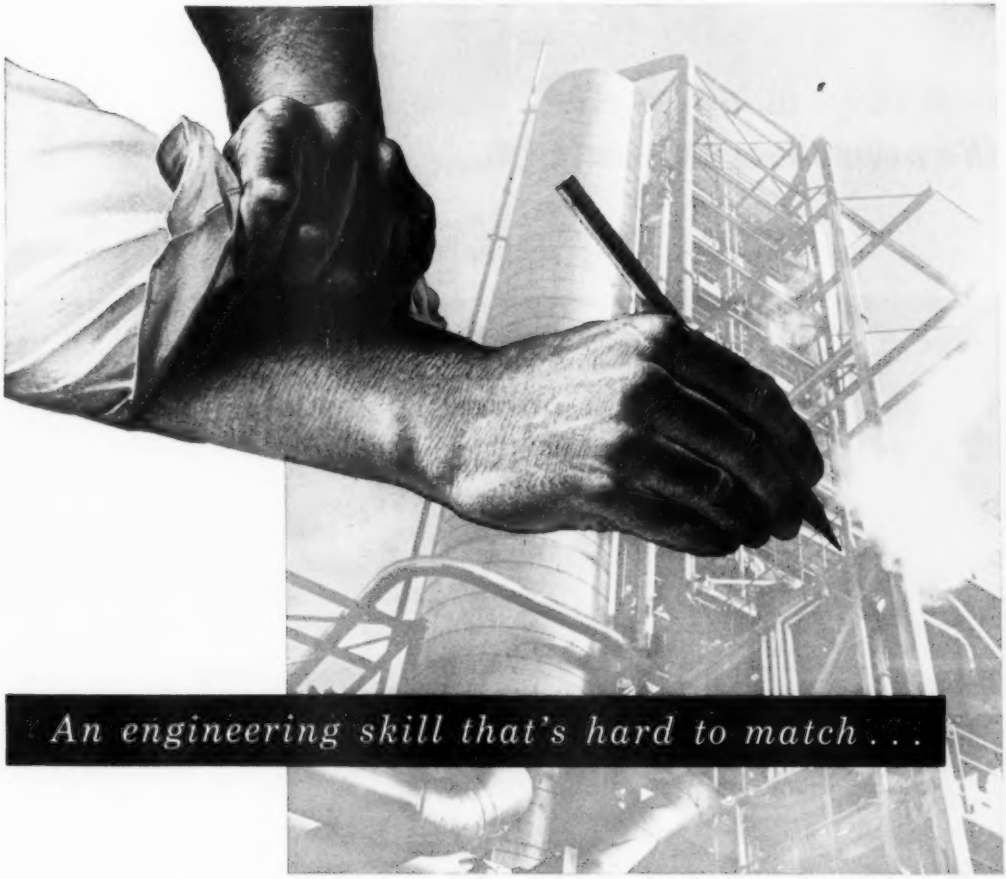

An engineering skill that's hard to match . . .

We mean the skill that's acquired after rolling up sleeves 600 times or more—to design and construct that many petroleum refining, petroleum chemical and chemical plants at sites all over the world.

These plants didn't just happen. Lummus men had ideas, practical imagination, the ability to work, a sharp sense of responsibility, and a company policy which placed no limit upon the physical facilities needed to do the job.

All this is worth its weight in gold—an appraisal which our clients express time and again. We see it as a healthy "atmosphere" in which new processes, new techniques, new equipment and new products are developed to our own high standards, and to the satisfaction and profit of our customers.

So we offer this suggestion: put us down as a group with the depth of chemical engineering talent and the breadth of experience to tackle *your* next engineering and construction project —whatever and wherever it may be. And to do it with a skill that's hard to match.

THE LUMMUS COMPANY

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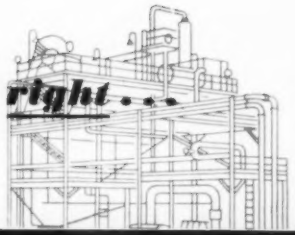
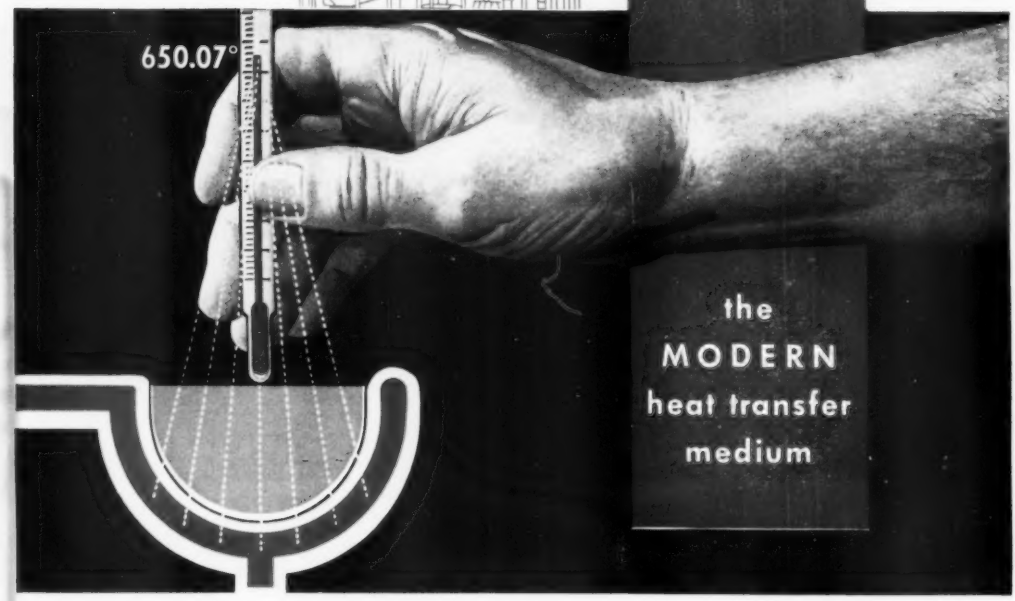
DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

the heat is on right . . .



DOWTHERM



MAINTAINS UNIFORM HEATING OVER ENTIRE PROCESSING SURFACE

Here's the best answer to the precise temperature control required in petroleum fractionation—DOWTHERM®. This material, a stable organic heat transfer medium, is used in a closed system in the same manner as steam but it offers *low pressures* at temperatures from 300°F. to 750°F. Thus, in this temperature range, carefully controlled and uniform heating is available, hot spots and overheating will be eliminated and the coking problem diminished.

Several pieces of equipment can be held at different constant temperatures by one DOWTHERM system, or if alternate heating and cooling are required—DOWTHERM also should be considered in your system.

If you need constant high temperatures at low pressures write Dow for complete DOWTHERM information.

ATTENTION PROCESS MEN . . . Use DOWTHERM . . . for heating and reboiling naphthas, kerosene, gas and oil, and for the production of special products . . . also for recovery systems of solvent refining units.

THE DOW CHEMICAL COMPANY
Midland, Michigan

The Dow Chemical Company, Dept. DO-18A
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DOW
CHEMICALS
INDISPENSABLE TO INDUSTRY AND AGRICULTURE

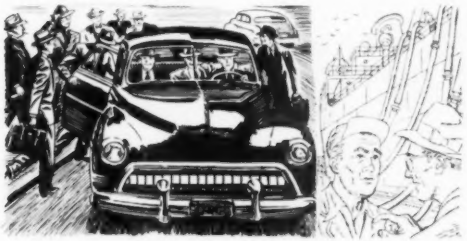
"Why shouldn't you haul the other fellow's oil?"

One of the things people ask *about Standard is why we do not let other oil companies use all of our tankers, marine terminals, and pipelines. They say, "Why shouldn't you haul the other fellow's oil?"*

The answer to that question is that we're mighty busy hauling our own, meeting our regular obligations to our customers. Standard just can't share all of its transportation equipment with other companies. And it's unfair to ask us to do it. It's like asking you to let everybody else use your car.

You go out and buy a car for yourself and your family—a car big enough for your needs. So with Standard. We provide whatever facilities it takes to handle our own crude oil and keep delivering our own finished products *where* and *when* they're needed, to customers who depend on us for service.

Now suppose you're driving your car and a hitchhiker thumbs a ride. You pick him up only if you want to. The choice is *yours*. So again with Standard. In our pipelines within a state's borders, crossing only privately-owned land, and in our tankers, we may choose to carry only our own oil.



But the way some people seem to want it, our freedom of choice would be gone. It's as if you were to be forced to stop and pick up everybody who lifted a thumb at you. We'd be required to carry *anybody's* oil in these tankers and pipelines, even if our own had to be set aside.

In time, if your car were taken over like that, you'd have to buy another for your *own* use. Once again, so with Standard. If we were forced to carry competitors' oil, we'd have to buy or build additional facilities to handle our own. This would mean increased costs to us, higher prices to you.

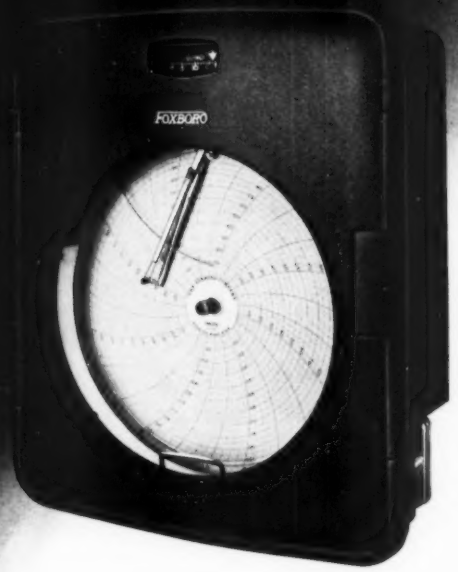
When they're needed for national defense, Standard makes its private facilities available for public use. But we can't do it as a general rule. We would lose our efficiency —a loss to you, our customers, as well as ourselves. We don't believe you want it that way.

STANDARD OIL COMPANY OF CALIFORNIA

• plans ahead to serve you better

better measurement and control of

FLOW



Wherever highest accuracy and complete reliability in flow measurement and control are vital to successful processing, it is significant that Foxboro Instrumentation is preferred. Whether your problem involves gas, steam, or liquids . . . in pipes, ducts, or open channels . . . the premium quality and complete diversity of Foxboro Instruments, backed by unequaled application experience, assure you an extra measure of satisfaction.

indicators • recorders • controllers • integrators
transmission systems • controlled valves • orifices
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Get Extra Value...
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- Electric furnace cast iron—fine-grained with physical properties far exceeding minimum specifications.

Reinforcing tie ribs between bonnet and end flanges—added strength where needed.

Yoke cap construction—rugged, makes servicing easy.

Pressure tested—to assure satisfactory service from the start.

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R-P&C VALVE DIVISION
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REFINERY construction versatile

Leveling For new 740-acre Venezuelan oil refinery, Tournadozer leveled and rough-graded land for building sites.

Near Puerta LaCruz, in the State of Anzoategui, Venezuela, Mene Grande Oil Company has installed an ultra-modern oil refinery in an area where only a short time ago there was nothing but unproductive wastelands. Adequate dock facilities were also constructed as well as housing units, recreational, educational, and medical centers for the laborers and technical staff.

TOURNADOZER handles 6 jobs

One of the busiest units on the 740-acre project was a highly mobile, rubber-tired C Tournadozer. Here are 6 of the jobs it handled prior to its current maintenance work:

(1) Push-loaded scrapers:

To speed initial land clearing, leveling, and grading for building sites, the powerful 180 h.p. Tournadozer push-loaded a fleet of high-speed, rubber-tired C Tournapulls.

(2) Pulled a Rooter:

When hard, rocky soils were encountered, the "C" pulled a LeTourneau Rooter to facilitate loading.

(3) Towed a flat-bed:

Because of its ability to travel over paved surfaces without planking, as well as over rough terrain, Tournadozer was an ideal high-speed prime mover for a flat-bed trailer used to carry heavy equipment and supplies around the project.

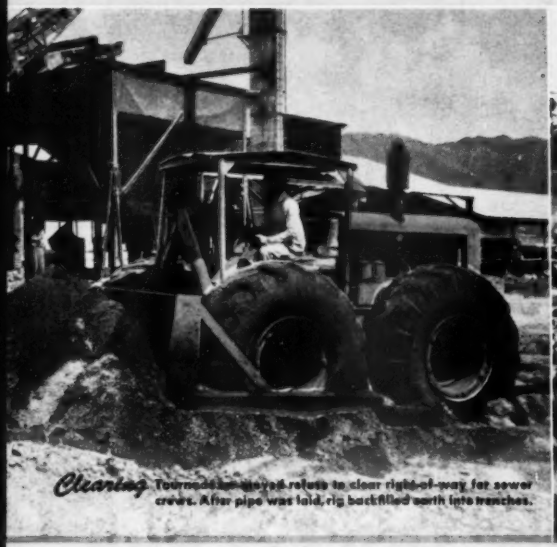
(4) Cleared right-of-way:

As a bulldozer, Tournadozer cleared refuse from the right-of-way for underground sewer lines.

LETOURNEAU LET EQUIPMENT

HIGH-SPEED, RUBBER-TIRED HAULING • EXCAVATING • LIFTING EQUIPMENT

and maintenance *speeded by* "work-and-run" C Tournadozer



Clearing Tournadozer moved refuse to clear right-of-way for sewer crews. After pipe was laid, rig backfilled earth into trenches.

Stockpiling Tournadozer kept busy between other jobs by stockpiling gravel and sand for the project's concrete plant.

(5) Backfilled trenches:

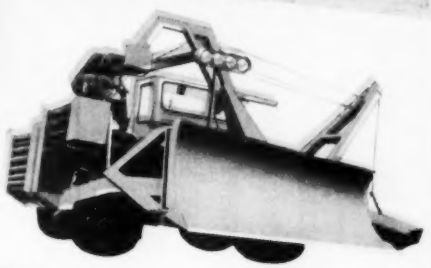
After drainage pipes were installed, the "C" dozed mixed dirt and rock back into the open trenches.

(6) Stockpiled sand and gravel:

At the project's cement plant, Tournadozer handled clean-up and piling assignments whenever needed.

Because it could drive anywhere at speeds up to 19 m.p.h., the Tournadozer frequently worked *all 6 jobs* in one day. On the 740-acre project, this mobility paid off in more work done per shift as well as a lower net cost per job.

For complete details on how rubber-tired Tournadozer can speed your work . . . cut cost per job . . . simplify spare parts inventory . . . and reduce maintenance costs, see your LeTourneau Distributor.



Side-boom Crane Attachment Increases Tournadozer's value

When you equip Tournadozer with side-boom crane, you get valuable added utility . . . a high-speed "trouble shooter" for your pipeline work. Tournadozer travels over highway or rough terrain under its own power at speeds up to 19 m.p.h. Here are some of this attachment's advantages:

Lifts 14 tons up to 12′ . . . 5 tons at maximum 12′ reach position. Boom and hoist lines are operated independently by twin, 2-speed, automatic-braking Tournatorque motors.

Instant-shift transmission completely eliminates shifting delays, jerky starts and stops when carrying load. Big 21.00 x 25 low-pressure tires cushion jars of traveling with a load.

Lowers load smoothly under power while rig is stopped or in motion. All craning operations are fingertip electric controlled. Rig can carry load over pavement or through sand.

Tournapull—Rooter—Tournadozer—Tournatorque—Trademark Reg. U. S. Pat. Off. EX 75-61

R. G. LeTOURNEAU, INC.

PEORIA, ILLINOIS

INDUSTRIAL GASOLINE ENGINES

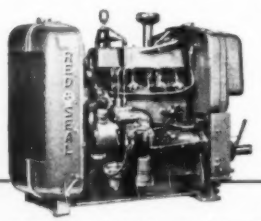
Model	Cyl.	Bore	Stroke	Displ.	Bare Engine H.P.
N56	4	2¼	3½	56	13.8 @ 2000 RPM
N62	4	2⅛	3½	62	15. @ 2200 RPM
Y69	4	2½	3½	69	21.4 @ 2400 RPM
Y91	4	2⅞	3½	91	28.5 @ 2400 RPM
Y112	4	3⅛	3½	112	32 @ 2400 RPM
F124	4	3	4⅛	124	36 @ 2400 RPM
F140	4	3⅛	4⅛	140	42 @ 2400 RPM
F162	4	3⅞	4⅛	162	49 @ 2400 RPM
F186	6	3	4⅛	186	60 @ 2400 RPM
F209	6	3⅛	4⅛	209	68 @ 2400 RPM
F226	6	3⅛	4⅛	226	73 @ 2400 RPM
M271	6	3⅛	4⅛	271	86 @ 2400 RPM
M290	6	3¼	4⅛	290	92 @ 2400 RPM
M330	6	4	4⅛	330	104 @ 2400 RPM
B371	6	4⅛	4⅝	371	110 @ 2400 RPM
B427	6	4⅝	4⅛	427	127 @ 2400 RPM
G134	4	3½	4⅛	134	32.2 @ 2000 RPM
G157	4	3½	4½	157	37.7 @ 2000 RPM
H227	4	3⅝	5½	227	54 @ 2000 RPM
H243	4	3¼	5½	243	58 @ 2000 RPM
H260	4	3⅜	5½	260	60.2 @ 2000 RPM
T371	6	4⅛	4⅝	371	119 @ 2400 RPM
T427	6	4⅝	4⅛	427	140 @ 2400 RPM
U501	6	4½	5¼	501	160 @ 2400 RPM
R513	6	4½	5½	513	164 @ 2400 RPM
R572	6	4¼	5½	572	182 @ 2400 RPM
R602	6	4⅜	5½	602	192 @ 2400 RPM
S749	6	5⅛	5½	749	217 @ 2200 RPM

INDUSTRIAL DIESEL ENGINES

Model	Cyl.	Bore	Stroke	Displ.	Bare Engine H.P.
GD157	4	3½	4½	157	37.5 @ 2000 RPM
HD243	4	3¼	5½	243	53.1 @ 2000 RPM
HD260	*4	3⅜	5½	260	57 @ 2000 RPM
TD427	6	4⅝	4⅛	427	102 @ 2000 RPM
RD572	6	4⅛	5½	572	137 @ 2000 RPM

*Available for Industrial applications only.

HD-260 Diesel Open Power Unit Illustrated.



Speed the Job . . . Cut the Cost . . . with *Dependable* RED SEAL POWER

Continental Red Seal power is giving a good account of itself in every type of oil field application within its broad power range. You find Red Seals in varying sizes and specifications handling more and more of the jobs in production, in distribution and in processing. They're available for use on all standard fuels. They deliver their full work quota at lower cost, with less down time, because each is engineered expressly for its job—built to do one thing and do it extra well.

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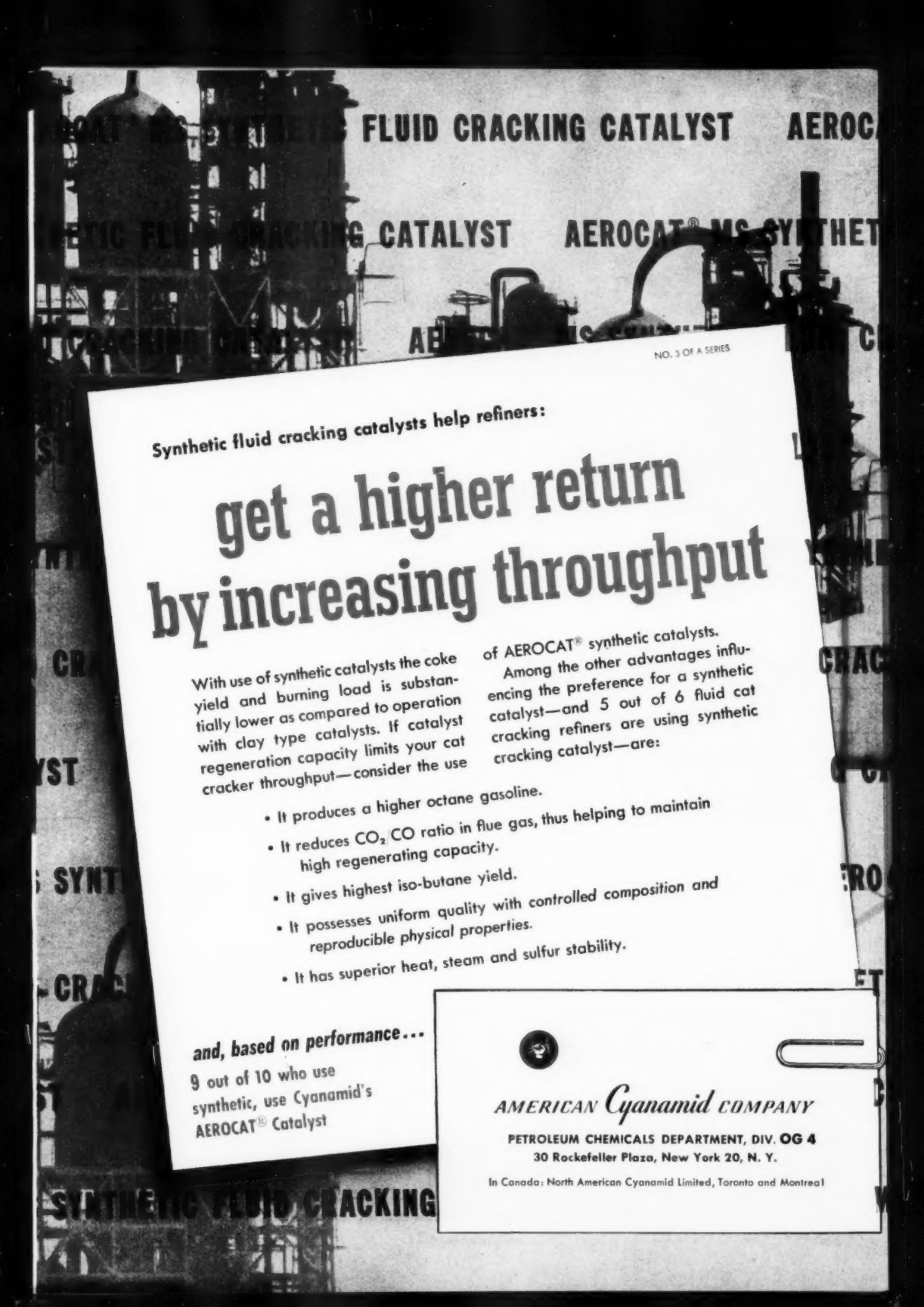


NO. 3 OF A SERIES

Synthetic fluid cracking catalysts help refiners:

get a higher return by increasing throughput

With use of synthetic catalysts the coke yield and burning load is substantially lower as compared to operation with clay type catalysts. If catalyst regeneration capacity limits your cat cracker throughput—consider the use of AEROCAT® synthetic catalysts.

Among the other advantages influencing the preference for a synthetic catalyst—and 5 out of 6 fluid cat cracking refiners are using synthetic cracking catalyst—are:

- It produces a higher octane gasoline.
- It reduces CO_2/CO ratio in flue gas, thus helping to maintain high regenerating capacity.
- It gives highest iso-butane yield.
- It possesses uniform quality with controlled composition and reproducible physical properties.
- It has superior heat, steam and sulfur stability.

and, based on performance...

9 out of 10 who use synthetic, use Cyanamid's AEROCAT® Catalyst

AMERICAN Cyanamid COMPANY

PETROLEUM CHEMICALS DEPARTMENT, DIV. OG 4
30 Rockefeller Plaza, New York 20, N. Y.

In Canada: North American Cyanamid Limited, Toronto and Montreal

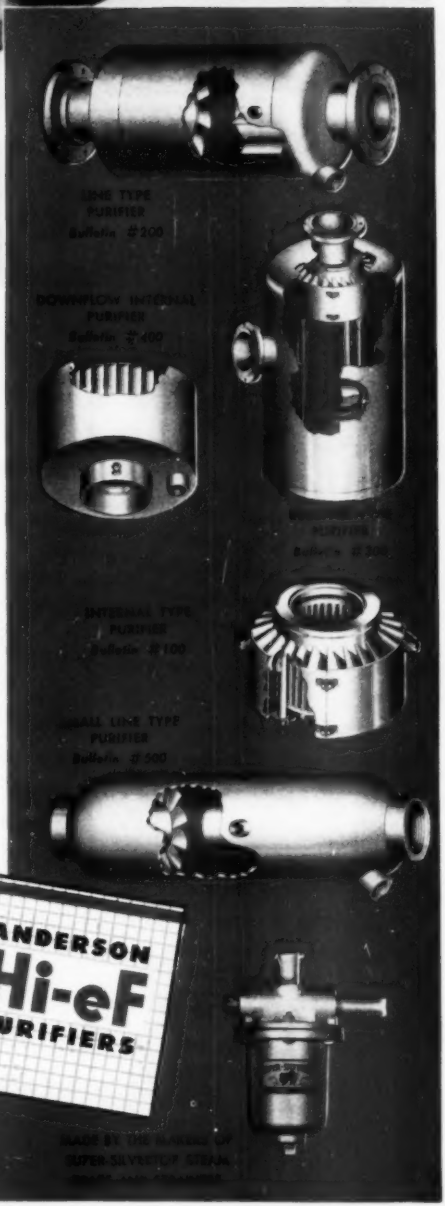
may be robbing your plant, too!

Guck is sludge, oil, line scale and other objectional entrainment in pipelines and equipment handling steam vapor, compressed air or gases.

For years "guck" has been robbing the industrial plants of America! Guck in exhaust gases and steam fouls costly equipment, causing downtime, increased maintenance and reducing efficiency. Guck in many cases makes exhaust steam so objectionable that it cannot be reclaimed. Guck vented with spent gases and vapors damages plant equipment and buildings.

Anderson Hi-eF Purifiers are the one sure way of ending not only "guck" but all steam and vapor entrainment problems. They clean up compressed air and steam lines, protect production and steam equipment, stop nuisances from vented gases and steam. In processing plants they economically reclaim the valuable solids in gases and vapors arising from the materials as it is processed.

The unique centrifugal element design of Anderson Hi-eF Purifiers is guaranteed to remove 99% of entrained liquids, solids, condensate, oil and greases from live and exhaust steam, processed gas, air and chemical vapors. These units cost much less than you might expect . . . require no maintenance . . . are self cleaning . . . and last a lifetime. If you you have a "guck" problem write to Anderson. Our engineering staff, with an impressive background of purifier experience, will gladly solve your problem.



PURIFIER DIVISION,
THE V. D. ANDERSON COMPANY
1992 West 96th Street • Cleveland 2, Ohio

Gentlemen: Please send additional information on Anderson Hi-eF Purifiers described in:

☐ Bulletin #100 ☐ Bulletin #300 ☐ Bulletin #500
☐ Bulletin #200 ☐ Bulletin #400

Name .....
Company .....
Address .....
City ..... **Zone** ..... **State** .....

Slightly Colossal

We are under no illusions that the twenty-seven films currently in the Ethyl Motion Picture Library will ever win "Oscars." By Hollywood standards they are only slightly colossal . . . but we believe they have been of tremendous value to our customers over the years.

What our films may lack in glamour, they most certainly make up in educational value. The subjects are ones that are close to the heart of any petroleum man trying to make better products, train his people to handle fuels more safely, or assist his customers to get more from the fuels and lubricants he supplies.

A glance at the following page will give you a good idea of the films we have available . . . and probably suggest uses for them in your own operations.

(*continued on next page*)

ETHYL
ETHYL CORPORATION

Slightly Colossal

(*continued from preceding page*)

Fire Power—A 24-minute film on the safe handling of gasoline, particularly in service stations and bulk plants.

Fundamentals of Fuel Knock—A highly technical report of fuel combustion studies being conducted at M.I.T. under an Ethyl grant. Running time, 27 minutes.

You're the Doctor—An interesting story about farm equipment service—in particular, a valve job on a tractor engine. 32 minutes.

There Is a Difference—Tells of a new service station operator learning about customer relations. Running time, 22 minutes.

Gasoline for Everybody—A brief but complete story of how gasoline is made and its importance to daily living. Running time, 13 minutes.

Pattern for Progress—A 20-minute color film about the influence of tractor power on agriculture as seen through the eyes of one farm family.

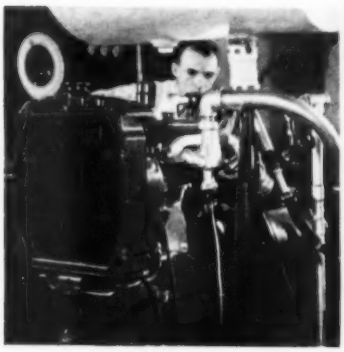
We will be happy to send you a complete catalogue of films in the Ethyl library. If you need a particular film in a hurry, our regional offices maintain a full stock for quick service. Of course, there is no charge for these films. They are a part of Ethyl's service to the oil industry.

ETHYL CORPORATION

NEW YORK 17, NEW YORK

. . . . . .

Ethyl service is backed by 29 years of antiknock experience



RESEARCH

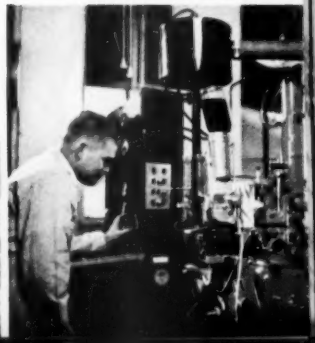
SUPPLY SERVICE

TECHNICAL NOTES

SALES HELPS

ROAD TESTING

GASOLINE TESTING



The Petroleum Industry

STOPS RUST!

with

RUST-OLEUM

The Practical Way to Save Pipes, Tanks, Derricks, Buildings, Pumps, Roofs, Fences

Ask the maintenance men who battle rust daily! They'll tell you that RUST-OLEUM is the practical answer. (1) It may be applied directly over surfaces *already rusted* without removing all the rust. Wirebrushing and scraping with sharp scrapers to remove rust scale and loose particles is all that is usually required... eliminating costly sandblasting and chemical pre-cleaning... often enabling one man to do the work of two. (2) RUST-OLEUM *beautifies as it protects in all colors, aluminum, and white.* (3) RUST-OLEUM *stops rust* on every rustable metal surface indoors and out.

See how RUST-OLEUM can cut your maintenance costs. Prompt delivery from Industrial Distributor stocks in principal cities in the United States and Canada.

RUST-OLEUM CORPORATION
2543 Oakton Street • Evanston, Illinois

May be applied directly over rusted surfaces without removing all the rust!
Available in All Colors, Aluminum and White

CLIP THIS TO YOUR LETTERHEAD
MAIL TO: RUST-OLEUM CORPORATION
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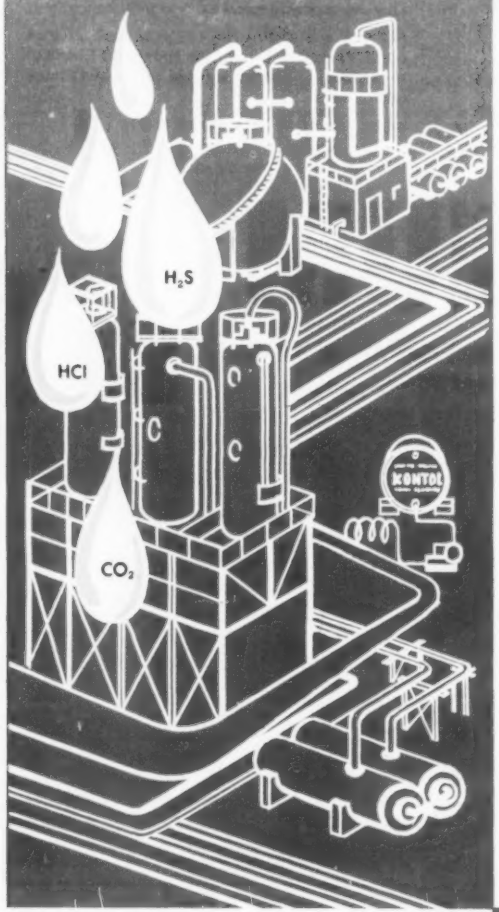
- ☐ Have a Qualified Representative Call
- ☐ Full Details on Free Survey
- ☐ Complete Literature
- ☐ Nearest RUST-OLEUM Source

STOP

CORROSION LOSSES



KONTOL

Corrosion Inhibitor is used effectively in the refinery to combat corrosion caused by moisture, chlorides, HCl, CO_2, H_2S and organic acids. Kontol inhibits attack by H_2S, stopping blister formation at its source.

KONTOL can be used to control the corrosion of flow lines, fractionating towers, debutanizers, depropanizers, and stripping columns. It is also effective in the protection of heat exchangers, gathering systems, separators, scrubbers and overhead products lines.

KONTOL does not affect the quality of refined products, with reference to end point, gum-formation, anti-knock rating, color, ash content and so on.

KONTOL can be continuously injected into a refinery flow system by means of a chemical feed pump, or by once-a-day batch injection by means of a lubricating device.

KONTOL provides protection against corrosion by adsorbing at metal surfaces as a thin, tough, impervious film which prevents contact by corrosive agents. It provides substantial protection against many kinds of refinery corrosion which, heretofore, have been accepted as being unavoidable.

For a prompt survey of your corrosion problems by a Tretolite Company refinery engineer, write or call the

Chemicals for the Petroleum Industry

CORROSION INHIBITING • DESALTING
DEHYDRATING • WATER DE-OILING
SCALE PREVENTING

TRETOLITE COMPANY

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SHOCKPROOF!

★ ALFCO ANTI-STATIK HORN Device grounds static electricity, insures safety.

Sectional view of Alfco Anti-Statik Horn

ALL ALFCO CARBON DIOXIDE FIRE EXTINGUISHERS WITH HOSE CONNECTIONS HAVE ALFCO ANTI-STATIK HORNS

All commercial Alfco Carbon Dioxide Extinguishers having hose connections are equipped with an exclusive Alfco Anti-Statik Discharge Horn which grounds static electricity, eliminating the possibility of shock to the operator from a static charge generated by rapid release of gas. Smaller size units with shorter swivel type horns do not require this feature. There is a capacity size model to meet your requirements from 20 lbs. down to 2½ lbs. Wheeled Engines also available in 50, 75, and 100 lb. sizes.

★ On All ALFCO Carbon Dioxide Hand Portable FIRE EXTINGUISHERS and WHEELED ENGINES EQUIPPED WITH HOSE CONNECTIONS

AMERICAN-LAFRANCE-FOAMITE Corporation

ELMIRA-NEW YORK-U.S.A.

ALFCO

Operators get EXTRA POWER for off-the-highway work

Extra power is what you need if your truck is going to serve you dependably and economically in rugged off-the-highway operations. And *extra power* is exactly what Dodge "*Job-Rated*" trucks give you!

In fact, Dodge "*Job-Rated*" trucks are the most powerful in Dodge history. For example, you can get a husky 3-ton model that provides 145 horsepower. Its extra-efficient *twin carburetion and exhaust system* assures maximum power under *all* operating conditions.

And it's *dependable* power, too! Such features as high-compression L-head engine design, sodium-cooled exhaust valves, silicon-chromium steel valve seat inserts, and surface-hardened crankshaft journals assure longer engine life with less "time off" for repairs.

Make sure that *you* get all the power you need for your toughest jobs, either on or off the highway. See your nearby Dodge dealer about a truck that *fits your job*—a Dodge "*Job-Rated*" truck.

DODGE "Job-Rated" TRUCKS

GULF at Port Arthur...

is using

Depend upon it—when petroleum refiners engineer a plant, they call for components they can depend upon. Like many other oil companies, they include OIC Valves—used in this Gulf Oil Company plant.

OIC Valves are *precision engineered, precision built, precision applied.* OIC engineers will help you choose the valves to do each job at lowest cost.

Write for your free copy of the newly revised "OIC Valve Cross-Reference Chart" to The Ohio Injector Company, Wadsworth, Ohio.

This huge tube still is a key unit in the production of the famous Gulfpride Motor Oil at the Port Arthur, Texas, Refinery of Gulf Oil Corporation. This refinery is one of the largest in the world, with a rated capacity of over 200,000 barrels per day.

OIC
FOUNDED 1883

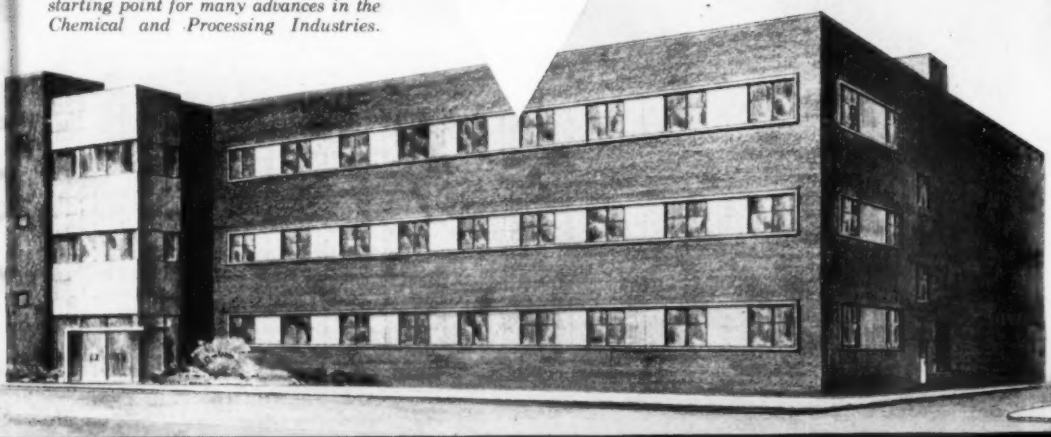
VALVES

FORGED AND CAST STEEL · IRON · BRONZE

This team can design, build and equip your plant!

Here is a team unique in the chemical and processing fields . . . a team of imagination and ingenuity, with years and years of experience in all phases of engineering. Thoroughly capable of carrying through any undertaking from flow sheet to turn-key operation—on a basis of unified responsibility. Big enough for the biggest job . . . flexible enough for *any* job. This team can competently and economically translate your ideas into an operating plant.

New Chemical Plants headquarters . . . starting point for many advances in the Chemical and Processing Industries.



CHEMICAL PLANTS DIVISION

BLAW-KNOX CONSTRUCTION COMPANY

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Why Ingersoll-Rand

VERTICAL PUMPS

are HIGH in performance

and LOW in installation and maintenance

OPERATION IS BETTER

These rugged, vertical process pumps have repeatedly proved their dependability and unusually high economy in services the world over. The shaft and impeller assembly is in complete radial balance. And positive alignment is maintained by accurate machined fits of all mating sections. The proven design of these units—with each part of the most suitable material for the application—assures *sustained* high efficiency.

INSTALLATION IS EASIER

The in-line arrangement of suction and discharge nozzles permits simple, straight-through piping—without loops or elbows. Piping can be located above or below floor level, as desired. Compact, vertical design conserves space—eliminates the need for large foundations, bedplates and grouting.

MAINTENANCE IS SIMPLIFIED

There is only one stuffing box—easily accessible through openings in the discharge head. Either conventional packing or the I-R Cameron Shaft Seal can be used. There is no thrust bearing to maintain, residual thrust being taken by the motor bearing. And the segmented inner casing assembly is easy to dismantle and assemble for inspection or servicing. Maximum interchangeability of impellers and diffusor sections reduces spare parts inventories.

The inherent advantages of vertical design particularly suit these pumps to many chemical and process services. Your nearest Ingersoll-Rand branch office engineer will be glad to study your next pumping problem with you. Whether the solution indicated calls for a vertical or horizontal unit, you are assured of obtaining the *right* pump for the job when you specify Ingersoll-Rand.

Ingersoll-Rand

CAMERON PUMP DIVISION
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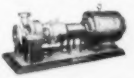
THERE'S AN I-R CENTRIFUGAL PUMP FOR EVERY PROCESS NEED

Single-stage, vertically split
Capacities—20 to 550 gpm
Pressures—to 300 psi

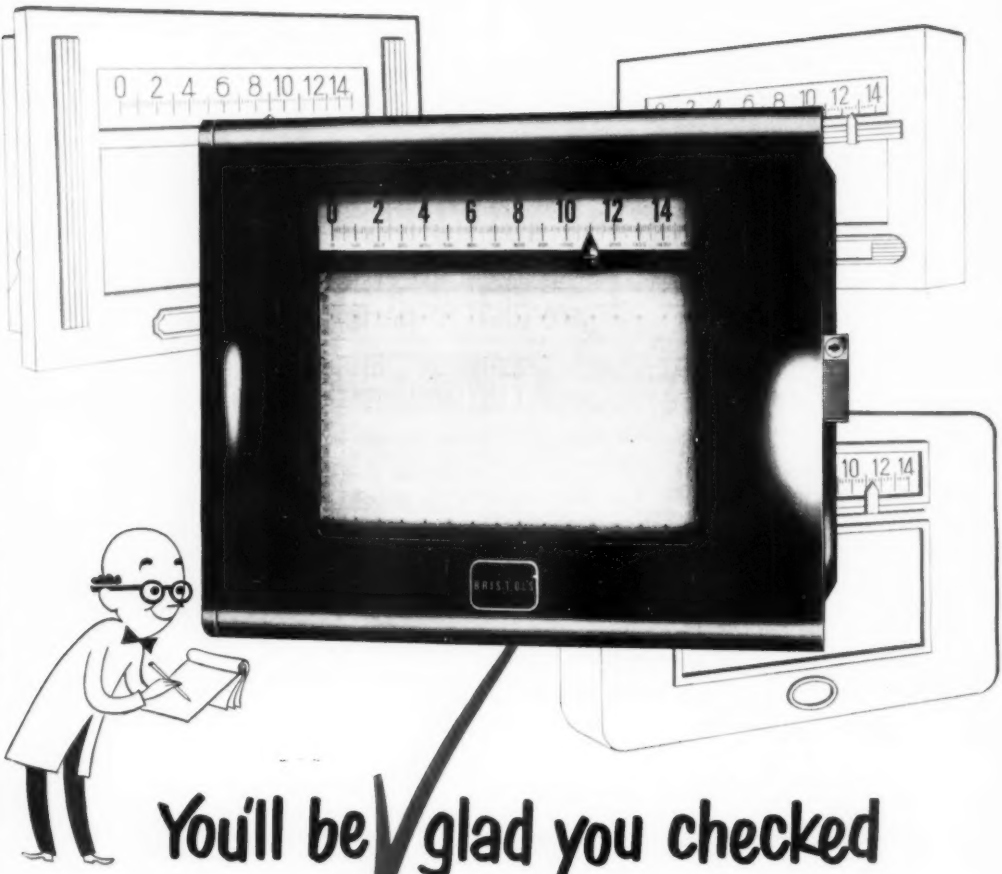


Single- and two-stage, vertically split
Capacities—10 to 3000 gpm
Pressures—to 600 psi

Single- and two-stage, horizontally split
Capacities—20 to 3500 gpm
Pressures—to 500 psi

Multi-stage, with cylindrical "double-case" construction
Capacities—to 2800 gpm
Pressures—to 3000 psi

COMPRESSORS — — AIR TOOLS — ROCK DRILLS — TURBO BLOWERS — CONDENSERS — CENTRIFUGAL PUMPS — DIESEL AND GAS ENGINES



You'll be glad you checked BRISTOL'S DYNAMASTER

Continuous-balancing electronic recorders

A high-speed, accurate electronic brain to measure, record, and control d-c voltage, d-c current, resistance, capacitance—or any variable that can be converted into those quantities.

The continuous-balancing circuit responds to minute changes *instantly*.

Available as a self-balancing bridge or potentiometer, the Dynamaster is a versatile, dependable, trouble-free measuring instrument.

BRISTOL

The dependable Guidepost of Industry

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

CHECK THESE ✓ practical features

Simple design for long, trouble-free operation

Little or no maintenance

Electronic component uses vacuum tubes available from any radio supply house

Full-scale pen travel in 7, 3, or ⅔ seconds

Chart speeds from ¾ in. per hour to 7200 in. per hour

Multipoint recorders up to 16 points

Same amplifier used on all Dynamaster models . . . can be removed and replaced with nothing but a screwdriver

Periodic automatic standardization on potentiometer models

Exceptionally unaffected by stray currents (1000 to 1 discrimination)

Practically immune to vibration or shock

FOR MORE INFORMATION *on how Dynamaster can solve your measurement problems, use the coupon to send for Catalog No. P1245.*

COMPANIES LIKE THESE *are using Dynamasters*

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Jones & Laughlin Steel Corporation
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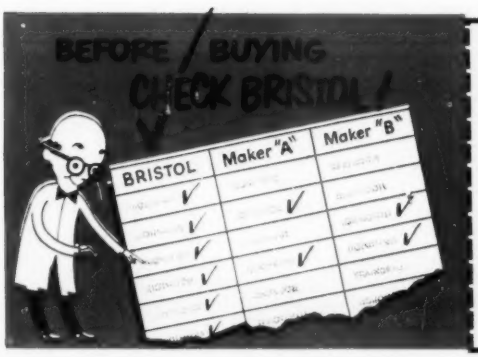

THE BRISTOL COMPANY
120 Bristol Road
Waterbury 20, Conn.

Please send catalog giving details of Dynamaster performance to:

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

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MILE AFTER MILE

You'll Get Better Performance with PITT CHEM Plasticized Enamel

Pipeline crews can tell you the advantages of applying Pitt Chem Plasticized Grade Enamel at any temperature from −20° F to 160° F. For mile-after-mile, ton-after-ton, they get the *same* excellent application characteristics because of the uniform high quality of Pitt Chem Plasticized Enamel.

As a *basic producer* of tar base pipeline enamels, we control every step of production from coal to finished product . . . in a plant devoted *exclusively* to the production of hot applied enamels. What's more, we back up the unvarying quality and dependability of supply with on-the-spot field service whenever you need it. ● *Additional information on Pitt Chem Plasticized, Modified, or Standard Tar Base Enamels is yours for the asking.*

* Standard Grade Tar Base Enamel
* Modified Grade Tar Base Enamel
* Plasticized Grade Tar Base Enamel
* Cold Applied Tar Base Coatings
* Synthetic Protective Coatings

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COAL CHEMICALS • AGRICULTURAL CHEMICALS • PROTECTIVE COATINGS • PLASTICIZERS • ACTIVATED CARBON • COKE • CEMENT • PIG IRON

This Simple Compressor Meets the Complex Needs of a Changing Petroleum Industry

It's the Nash!

Here is a compressor presenting advantages found in no other device. Nash Compressors have only one moving part, rotating without metallic contact with the pump casing. No internal lubrication is required. Yet they produce 75 lbs. pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure.

There are no valves, gears, pistons, sliding vanes, or other complicated wearing parts in a Nash. Compression is secured by an entirely different principle of operation. Because of this, gas pumping problems difficult with ordinary pumps are often easily handled by the Nash. For example, Nash Pumps are standard equipment in the Synthetic Rubber Industry, where they have met the needs of new and difficult processes.

Nash Compressors are compact and save space. They run without vibration, and compression is without pulsation. They maintain original performance over long periods. Service is assured by a nationwide net-work of Engineering Service offices. Instructive bulletin shows how they operate. Write for it.

- One moving part.
- No internal wearing parts.
- No valves, pistons, or sliding vanes.
- No internal lubrication.
- Low maintenance.
- Slugs of liquid entering pump do no harm.
- Non-pulsating pressure.
- Saves floor space.
- 75 pounds in a single stage.

NASH ENGINEERING COMPANY
274 WILSON, SO. NORWALK, CONN.

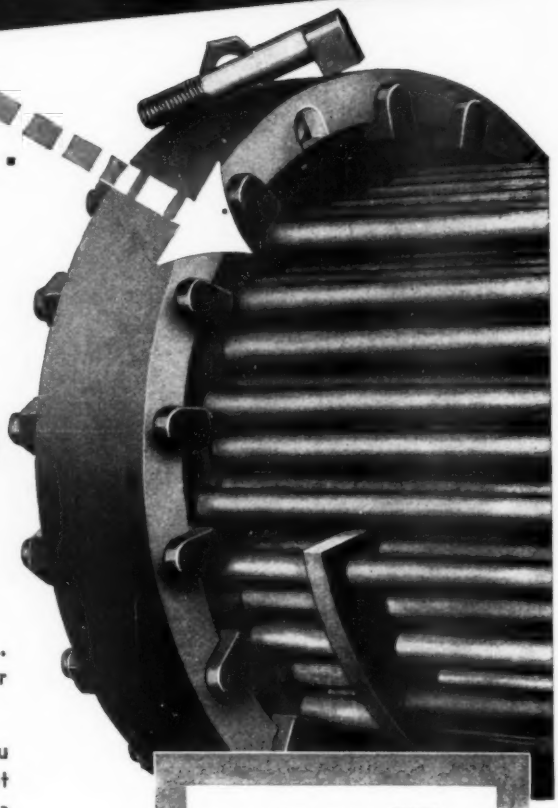
NO LEAKS HERE

with the patented . . .

Vogt

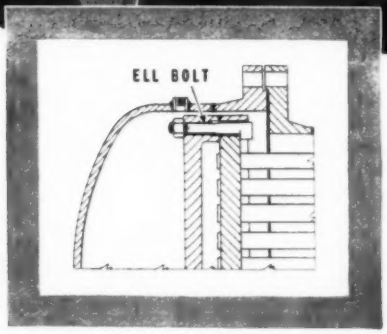
ELL BOLT CONSTRUCTION

of Floating
Tube Sheet Assembly



YOU LOSE when an exchanger leaks . . . with the possibility of fluid contamination, or frequent shutdowns for repairs.

None of these evils need plague you when you employ the Vogt patented floating tube sheet assembly because there is no distortion of a split ring to worry about in making up the joint time after time. It's easy to make tight and it stays tight!



Bulletin HE-6 is a pictorial presentation of standard and special types of Vogt Heat Exchangers. Write for a copy on your letterhead.

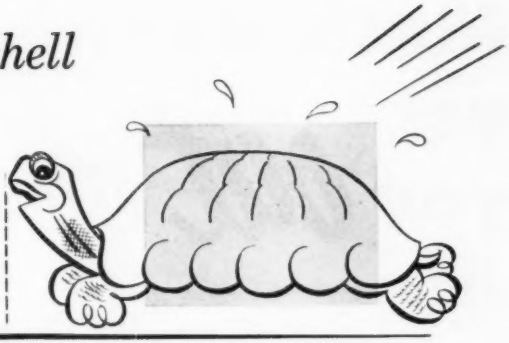
Patent Nos.
1,895,735
2,232,478

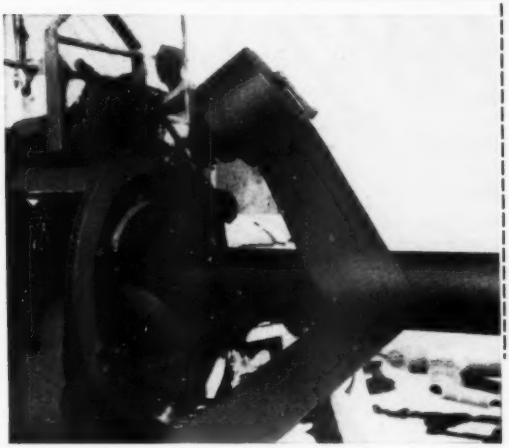
HENRY VOGT MACHINE CO. INC. • LOUISVILLE 10, KY.

Branch Offices. New York, Philadelphia, Cleveland, Chicago, St Louis, Dallas

Vogt HEAT TRANSFER EQUIPMENT

Like the turtle's tough shell that protects him so well...





Johns-Manville Asbestos Felt protects oil and gas pipe lines

Johns-Manville Asbestos Pipeline Felt now protects more than 100,000 miles of oil and gas pipe lines! *It is the only type of wrapper that has survived over 50 years of service in all types of soils.*

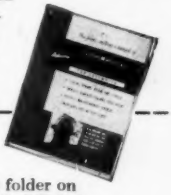
Johns-Manville Asbestos Felt is a sturdy product. It is resistant to rot and decay, and to acid and alkali soils. It has both the thickness and the toughness necessary for shielding pipe line enamels from damaging earth loads and soil stresses. These advantages make it possible for the protective enamel pipe coating to function properly against corrosion.

Johns-Manville Asbestos Felt is flexible. It wraps easily without cracking. It guards enamel from impact damage both during installation of field-wrapped pipe, and during transportation and installation of mill-wrapped pipe.

There are important economic benefits, too! Johns-Manville Asbestos Felt will help add many years to the life of the pipeline and help to keep maintenance costs low.

Johns-Manville Asbestos Pipeline Felt can be had in any width from 2" to 60", in any length desired.

For additional information and a sample of Johns-Manville Asbestos Pipeline Felt, simply fill in and mail the coupon provided below.



Johns-Manville
Asbestos
PIPELINE FELT

Johns-Manville
Box 290, New York 16, N. Y.
Please send me a copy of the sample folder on Johns-Manville Asbestos Pipeline Felt, PP-22A.

Name_____

Address_____

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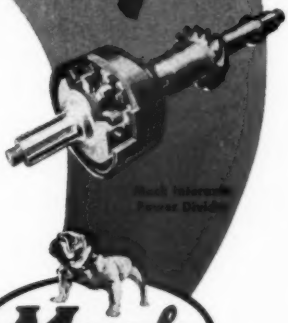
Mack six-wheelers get you *out of the rough*

Rough terrain or hub-deep mud holds no terrors for Mack six-wheel trucks. You can count on these unfaltering Macks to take your loads "out of the rough"...to maintain steady, dependable schedules...because they have the unique advantage of Mack's *Balanced Bogie with exclusive Power Divider.*

With the Mack Power Divider, a non-spinning true differential, torque is divided between the two bogie axles and between the four driving wheels. Delivering torque smoothly and continuously without destructive shock in proportion to wheel traction, the Power Divider stops power waste through useless slipping and wheel spinning–keeps Macks moving where other trucks bog down.

If your present truck equipment is having a hard time because of hard going, it will pay you to investigate the benefits you get from Mack six-wheelers in unfailing reliability and uninterrupted production...greater profits through greater output at lower cost. Write or call your nearest Mack branch or distributor.



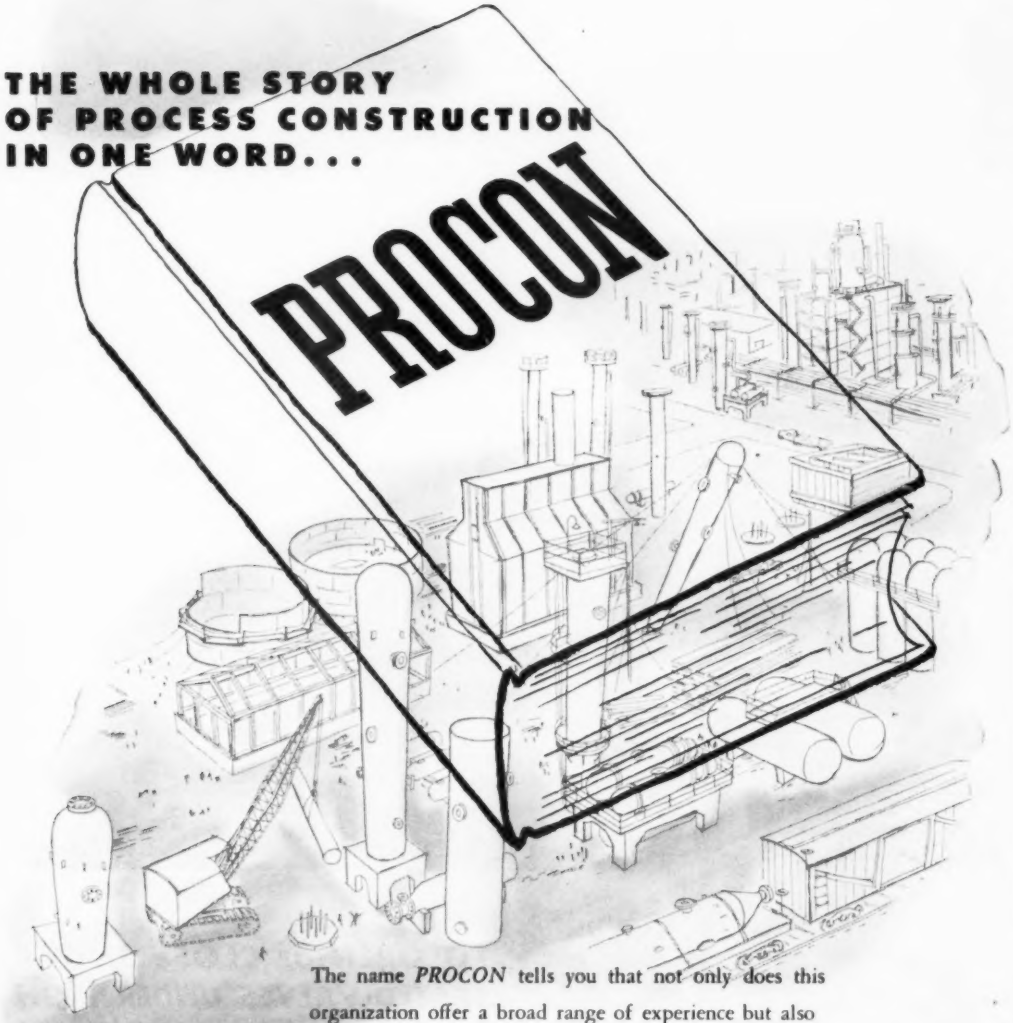
Mack TRUCKS

ast them all

Mack T... Empire State Building, New York 1, N. Y. Factor... nches and distributors in all principal cities for ser... and parts. In Canada: Mack Trucks of Canada, Ltd.

In tough oil field service Mack six-wheelers get you "out of the rough" with unfailing dependability.

THE WHOLE STORY OF PROCESS CONSTRUCTION IN ONE WORD...

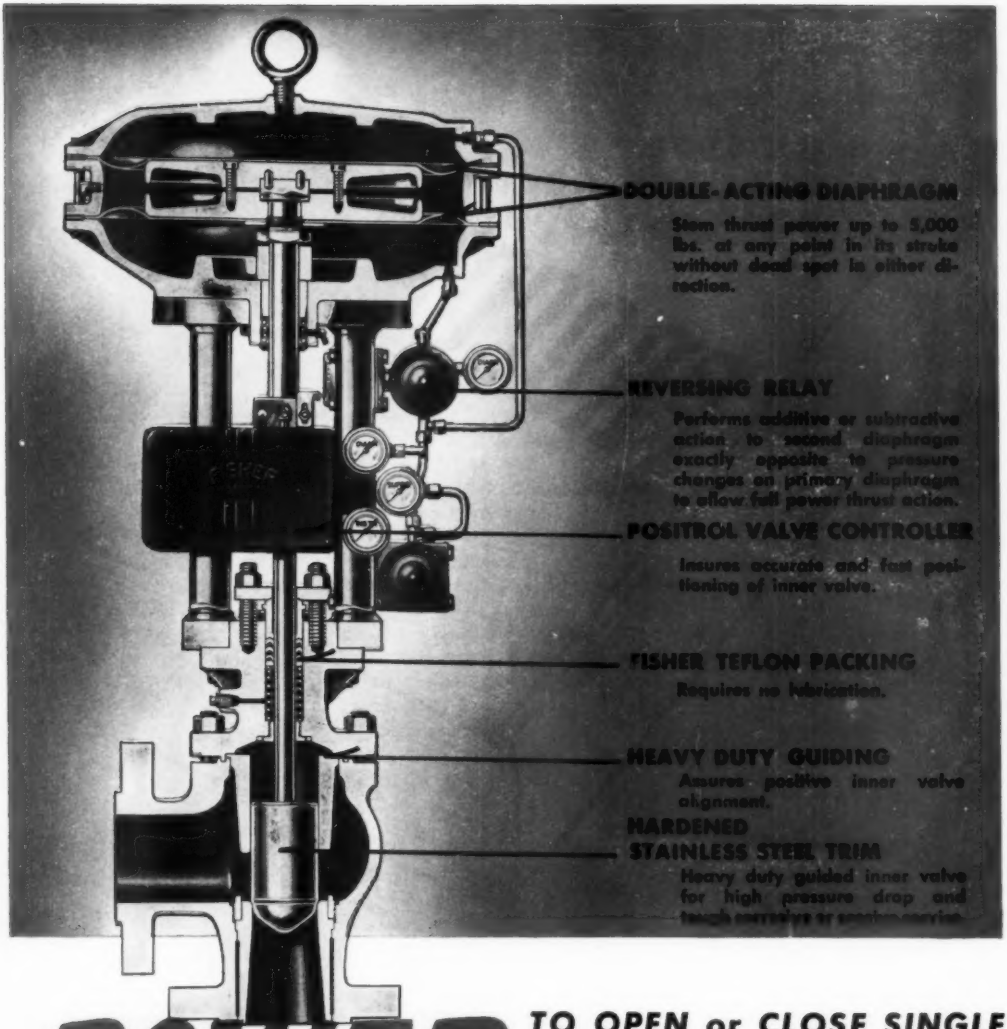


The name *PROCON* tells you that not only does this organization offer a broad range of experience but also provides the necessary flexibility for a practical and efficient construction service on all types of processing facilities. In one word—*PROCON*—is an accurate definition of complete process construction service.

PROCON *Incorporated*

PROCESS CONSTRUCTION

75 EAST JACKSON BLVD., CHICAGO 4, ILLINOIS


DOUBLE-ACTING DIAPHRAGM
Stem thrust power up to 5,000 lbs. at any point in its stroke without dead spot in either direction.
REVERSING RELAY
Performs additive or subtractive action to second diaphragm exactly opposite to pressure changes on primary diaphragm to allow full power thrust action.
POSITROL VALVE CONTROLLER
Insures accurate and fast positioning of inner valve.
FISHER TEFLON PACKING
Requires no lubrication.
HEAVY DUTY GUIDING
Assures positive inner valve alignment.
HARDENED
STAINLESS STEEL TRIM
Heavy duty guided inner valve for high pressure drop and

POWER

TO OPEN or CLOSE SINGLE SEATED VALVES UNDER HIGH PRESSURE DROP CONDITIONS

Fisher Type 5700-458 "AMT" pressure balanced diaphragm motor valve will actuate large single-seated valves for tight shut-off on high pressure drops. It features full pneumatic performance — no springs, no levers or weights. Double diaphragm avoids backlash effects probable with single diaphragm construction. Develops up to 5,000 lbs. stem thrust with 30 lbs. air supply. Designed for fast stroke action. Fully strokes inner valves in 13 seconds.

WRITE TODAY FOR BULLETIN E-5700

FISHER AMT*

DIAPHRAGM MOTOR VALVES FOR HEAVY DUTY SERVICE

* AMT "Answer Me Twice". In action, pressure added to one diaphragm, subtracted from other.

FISHER GOVERNOR COMPANY Marshalltown, Iowa

Remember—the trade marks "tt" and "TUBE-TURN" are applicable only to products of TUBE TURNS, INC.

Engineered to cut maintenance manhours

Scrappy says, "Aid defense—more scrap today... more steel tomorrow."

Write Dept. J-3 for free booklet on Allowable Working Pressures. Use coupon on reverse side.

CONSIDER THIS when you specify welding fittings for permanent, leakproof piping . . . the kind that's maintenance-free:

TUBE-TURN Welding Tees are drawn from seamless tubing to a barrel shape—the form every tee wants to assume under pressure. This feature, and the generous crotch radius and thickness, explain why TUBE-TURN Welding Tees withstand more pressure than required. Bursting pressures obtained in tests of representative fittings have averaged over 25% higher than required by standard codes.

For this extra quality at no extra cost get in touch with your nearby TUBE TURNS' Distributor. You'll find one in every principal city.

Be sure you see the double "tt"

TUBE TURNS, INC. LOUISVILLE 1, KENTUCKY

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago • Houston • Tulsa • San Francisco • Los Angeles
TUBE TURNS OF CANADA LIMITED, CHATHAM, ONTARIO... A wholly owned subsidiary of TUBE TURNS, INC.

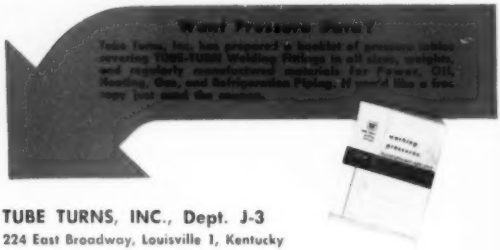
Prefabricated sections simplify by-pass job

Sunday job...cold and muddy! **This shop-fabricated unit comprising valves, pipe and fittings is being lowered into pit. This distribution main line by-pass job is part of a large northern Ohio utility's expansion program. The operations illustrated took place on Sunday. Time counted!**

Ready for connection. **Near end will connect to new 26-inch line. Far end will connect to existing 20-inch line. TUBE-TURN Welding Fittings and Flanges were used in this fabrication. Fittings include 90° elbows, saddles and concentric reducer.**

Connection takes a jog. **Both ends of by-pass had to be lower and off center of the lines. The problem was solved easily by making directional changes with prefabricated units like this 26-inch connection, comprising TUBE-TURN 45° Welding Elbows and pipe.**

Takes only 2 hours. **This view shows by-pass from 20-inch end with welder applying finishing touches on the connection. All connections fitted perfectly. Entire job of lowering by-pass unit and welding into lines took two hours. Contractors: Hattendorf-Bliss, Inc.**



TUBE TURNS, INC., Dept. J-3
224 East Broadway, Louisville 1, Kentucky

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Position .....

Company .....

Nature of Business .....

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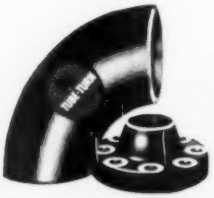

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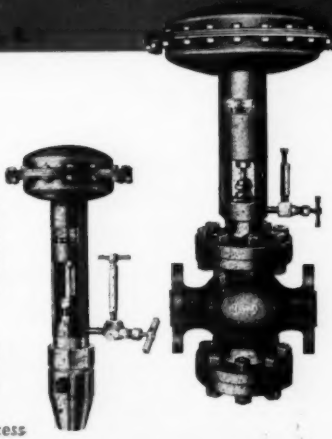

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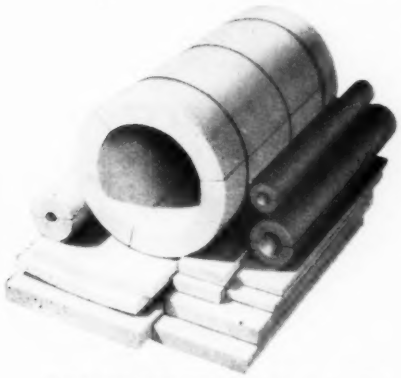
Kaylo Heat Insulation is a hydrous calcium silicate—a revolutionary heat-saving material—outstanding both in performance and ease of application.



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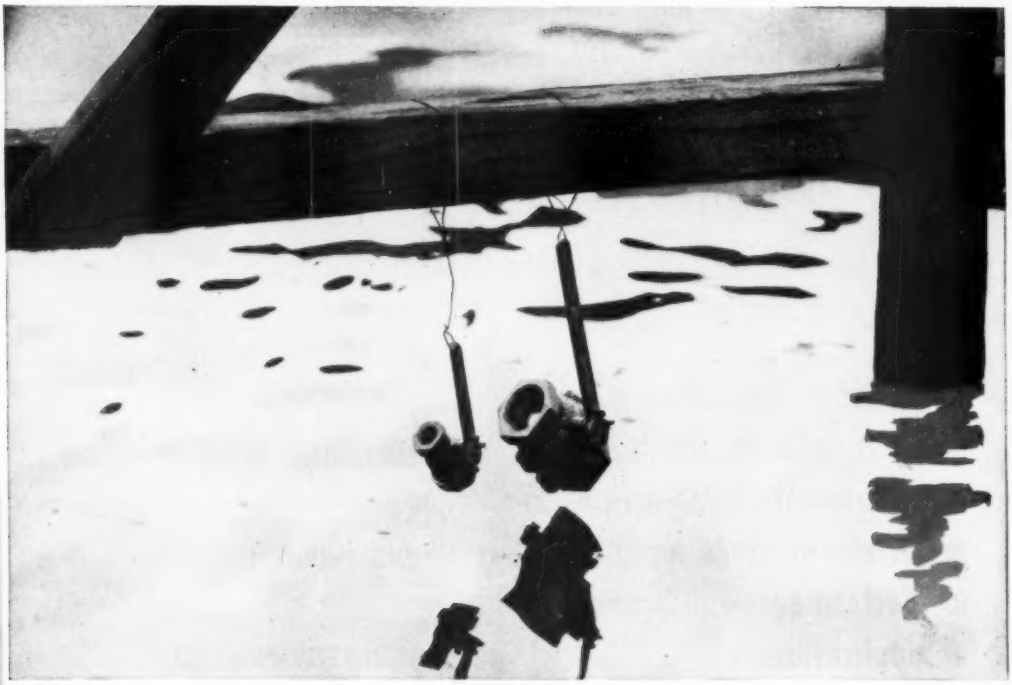

THESE ROCKWOOD BALL VALVES were undamaged after hanging from a Connecticut pier for 3 months.

90-Day Exposure to salt water leaves Rockwood Valves unharmed

The dramatic test for Rockwood Ball Valves, shown above, was conducted by a public official of New Haven, Connecticut.

He suspended a ¾" and a 2" bronze valve from his pier. He hung the valves at the mean tide level so that they were alternately immersed in salt water and exposed to salt air . . . then left them in a partially open position for 3 months.

Result?

After being taken apart, examined, reassembled and retested, both valves were found free from any sign of leakage! *From all appearances they were in no way affected by the severe exposure conditions to which they were subjected.*

WHAT THIS TEST MEANS TO YOU

You, too, can depend on Rockwood Ball Valves not only in lines handling salt water but also in lines handling all types of liquids and gases such as carbon dioxide, nitrogen, paraffin and asphalt base petroleums, alcohol and others. Rockwood Valves are built to stand the gaff.

Available in bronze in pipe sizes from ½" to 2" and in cast steel from 3" to 4". Recommended for 300 psi working pressure.

If you are not now using Rockwood Valves why not write for Bulletin V-4 today? Get complete data including prices and applications.

INDIVIDUAL PARTS of Rockwood Valves are here shown after 90-day water test. Note excellent appearance.

★ Leakproof service
★ Full round flow
★ Quick opening and closing
★ No maintenance

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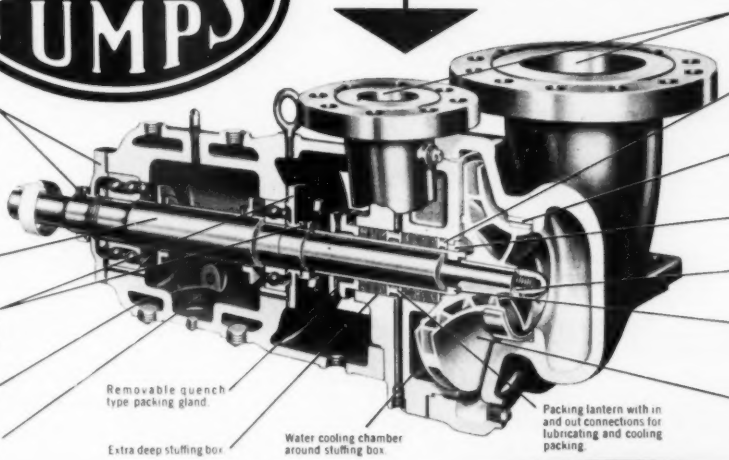
Top suction and top discharge design. End-suction design available.
By-pass lantern to relieve stuffing box pressure back to suction.
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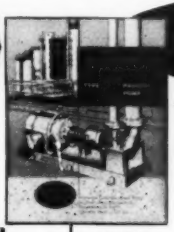

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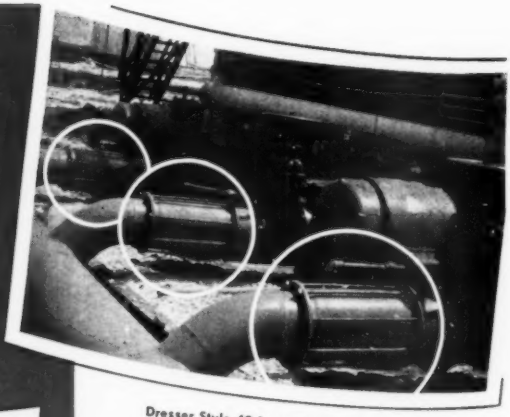
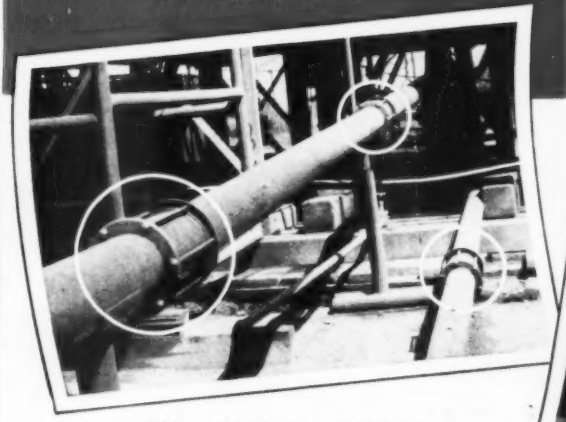
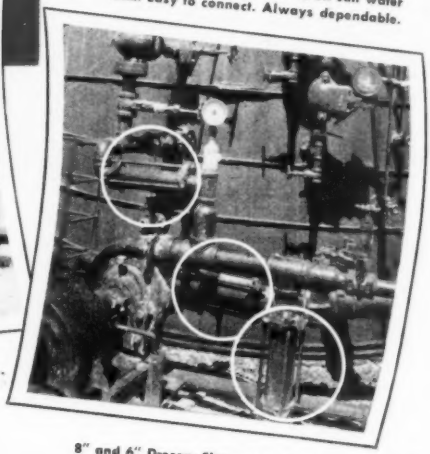
DRESSERS



Dresser Style 40 Long Sleeves on salt water tank. Easy to connect. Always dependable.



10" Dresser Long Sleeves on cooling tower lines. Snug and tight despite vibration.



8" and 6" Dresser Sleeves on mud lines to drill rig. "Flexible-Tightness" absorbs line "give and take".

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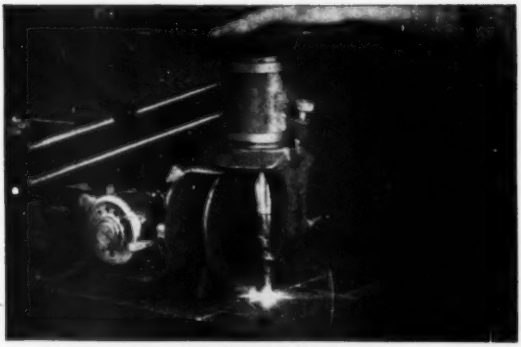
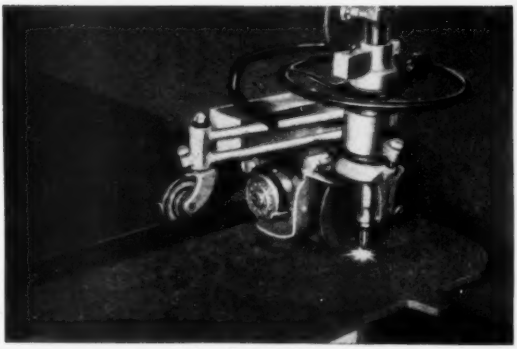
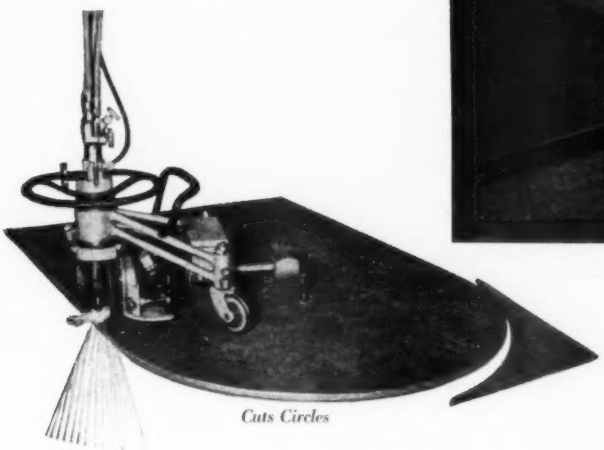


Cuts Irregular Shapes



Cuts Straight Lines



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In large and small shops alike, the OXWELD CM-16 Portable Cutting Machine fills an unbelievably wide variety of oxygen cutting requirements. It cuts circles automatically. Hand-guided, it cuts irregular shapes. Operated on track, it cuts straight lines.

Indoors or out—wherever steel needs shaping—the CM-16 makes it easy to "tailor" parts as fast as the work can be laid out. *And its ready adaptability for special jobs is limited only by its operator's ingenuity!*

The CM-16 sets up as quickly as any manual outfit. It weighs only 45 lb., travels directly on the work, and is easy to carry from job to job. In normal use, it cuts up to 4 in. of steel; with standard accessories, it cuts materials up to 18 in. thick and it cuts bevels.

Any LINDE representative will be glad to show you how the OXWELD CM-16 Portable Cutting Machine can boost production and cut fabricating costs in your shop. Write for catalog, Form 4487, or call the LINDE Office nearest you today for a free demonstration.

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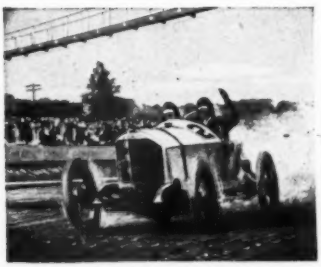
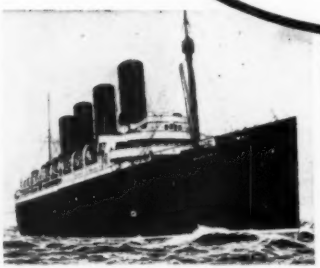


1915—Ralph DePalma wins Indianapolis Speedway Race with average speed of 89.84 m.p.h. Credits great performance of his car to engine protection provided by Mobiloil!

•

1931—Lee Wallard averages record-smashing 126.244 m.p.h. to take 500-mile Indianapolis Classic. For almost 4 hours his engine raced at top speed—guarded by heavy-duty Mobiloil!



1910—R.M.S. *Mauretania* captures Blue Ribbon honors by crossing Atlantic in 4 days, 10 hrs., 41 min. Gargoyle Marine Lubricants protected her turbines, auxiliary machinery!

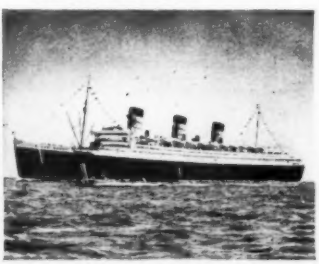
•

1932—The *Queen Mary* holds present transatlantic speed record of 3 days, 20 hrs., 42 min. Like every Atlantic Blue Ribbon winner since 1910, she is protected 100% with Gargoyle products.

1933—Wiley Post makes history's first solo flight around the world—time: 7 days, 18 hrs., 49½ min. To assure dependable, full-powered engine operation, Post used Mobiloil Aero!

•

1952—Pan American World Airways' global flights take 3 days, 21 hrs., 40 min. actual flying time. Their record of dependability has been set with aid of Mobiloil Aero!



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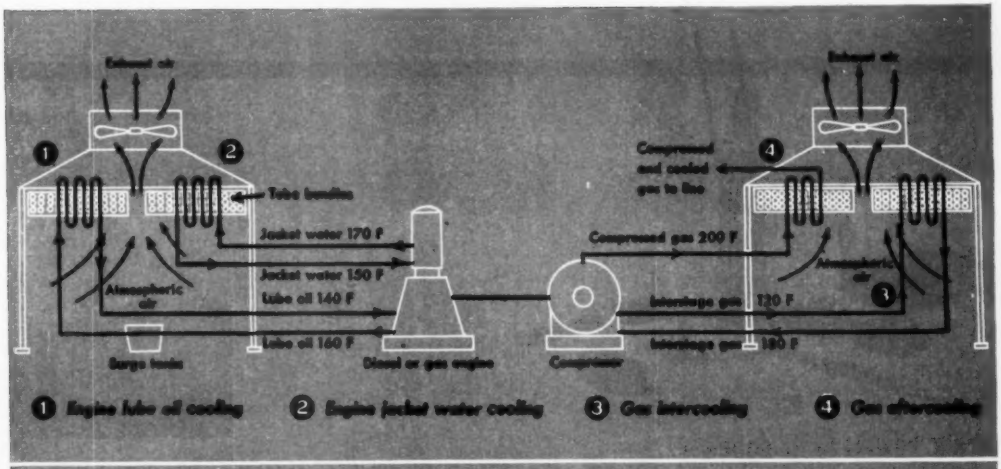
SOLVE ALL 4 COOLING PROBLEMS



in high-pressure gas compressor stations

In a typical high-pressure gas compressor station, two ALCO Aircoolers shown in the illustration perform four major cooling duties: (1) engine lube oil cooling (2)engine jacket water cooling (3) gas intercooling (4) gas aftercooling.

Versatile ALCO Aircoolers are particularly effective in this type installation because they are designed to give long, efficient performance. Such troubles as scale, costly water treatment and other cooling problems are eliminated.

The heart of the ALCO Aircooler is the ALCO fin tube, which provides an extended outside surface for maximum heat transfer efficiency, coupled with low air-flow resistance for economy in operation. A continuous helically wound copper fin is bonded to the tube with lead-tin alloy, and the external tube surface is coated with this alloy to improve atmospheric corrosion resistance. The entire unit is quickly and easily assembled in the field.

To put all these money saving features to work for you, call your nearest ALCO Sales Engineer at Beaumont, Chicago, Houston, Los Angeles, New York or Tulsa for more information or

Send Coupon for ALCO Aircooler Bulletin.

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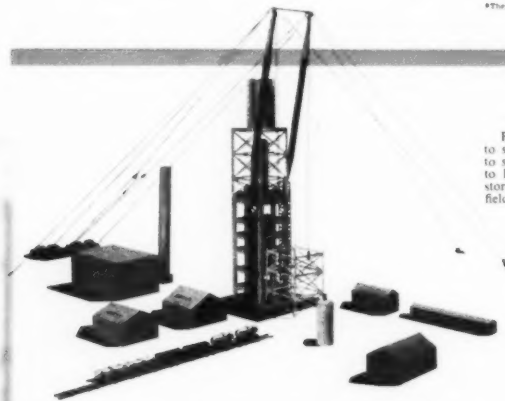
It took 60 years to save three months

on Socony's new cat-cracker*

The cat-cracker, the most important processing unit in a refinery today, is usually built from the ground up like a skyscraper—one or two floors at a time. But Fluor has developed a new time-saving technique of designing the component parts so that they can be fabricated on the ground simultaneously and lifted into place, thereby making more efficient use of manpower and equipment. Construction crews work in perfect coordination on a production-line basis to effect substantial savings in construction costs, but above all *in time!*

Fluor designed and constructed the catalytic cracking unit shown here for Socony-Vacuum at Augusta, Kansas. It stands 268 feet high, equivalent to a 22-story building. Nine months and 13 days after foundation was poured, it went on stream for 15,000 barrels a day, three months earlier than could be normally expected if built by conventional methods under similar circumstances. This airlift TCC unit processes about 1½ million barrels of oil in three months; that's why getting it into operation in the shortest possible time was an all-important objective.

*Thermofor catalytic cracking unit built for Socony-Vacuum Oil Company at their Augusta, Kansas refinery.

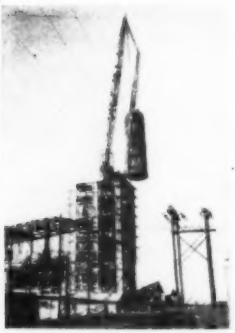


First, an experimental model was built to scale to check basic rigging design, to study actual erection problems, and to locate the most efficient work and storage areas before starting work in the field. The unit stood 5½ feet high.

October 26

Reinforced concrete was used to a height of 100 feet for fire protection. While the base was being poured (August 21, 1950), these concrete panels weighing 85 tons each were being cast on the ground slab.

Here's how it was done— from conception to *Completion*



December 22

In spite of sub-zero weather, the building marathon continues. The Reactor weighing 100 tons is being hoisted 100 feet into the air. It took less than an hour to complete this operation. The cracking process takes place in this unit.

January 4

This steel section, assembled on the ground and weighing 110 tons, was lifted 160 feet and lowered into place over the Reactor. It supports the Hot Catalyst Bin. This is one of 28 major lifts varying in weight from 60 to 125 tons.

March 5

After the last steel section was set, the Separator Surge Drum (63 tons) is raised into place on top. This was the last lift to be made. Total height is now 268 feet, 22 stories high, and is one of the tallest structures in Kansas.

May 10

Operation testing completed and ready for start up, 9 months and 13 days after foundation was finished. This cat-cracker is capable of processing 630,000 gallons of oil every day. Fluor has four more similar units under way.

For 60 years Fluor has been building for industry and is among the leaders in plant construction for the oil, gasoline, chemical and power industries in and out of the continental United States. If time-saving is your concern, take time to contact your nearest Fluor district office for details. Write for Bulletin CC2521 describing Fluor activity in the construction of Fluid and Thermofor cat-crackers.

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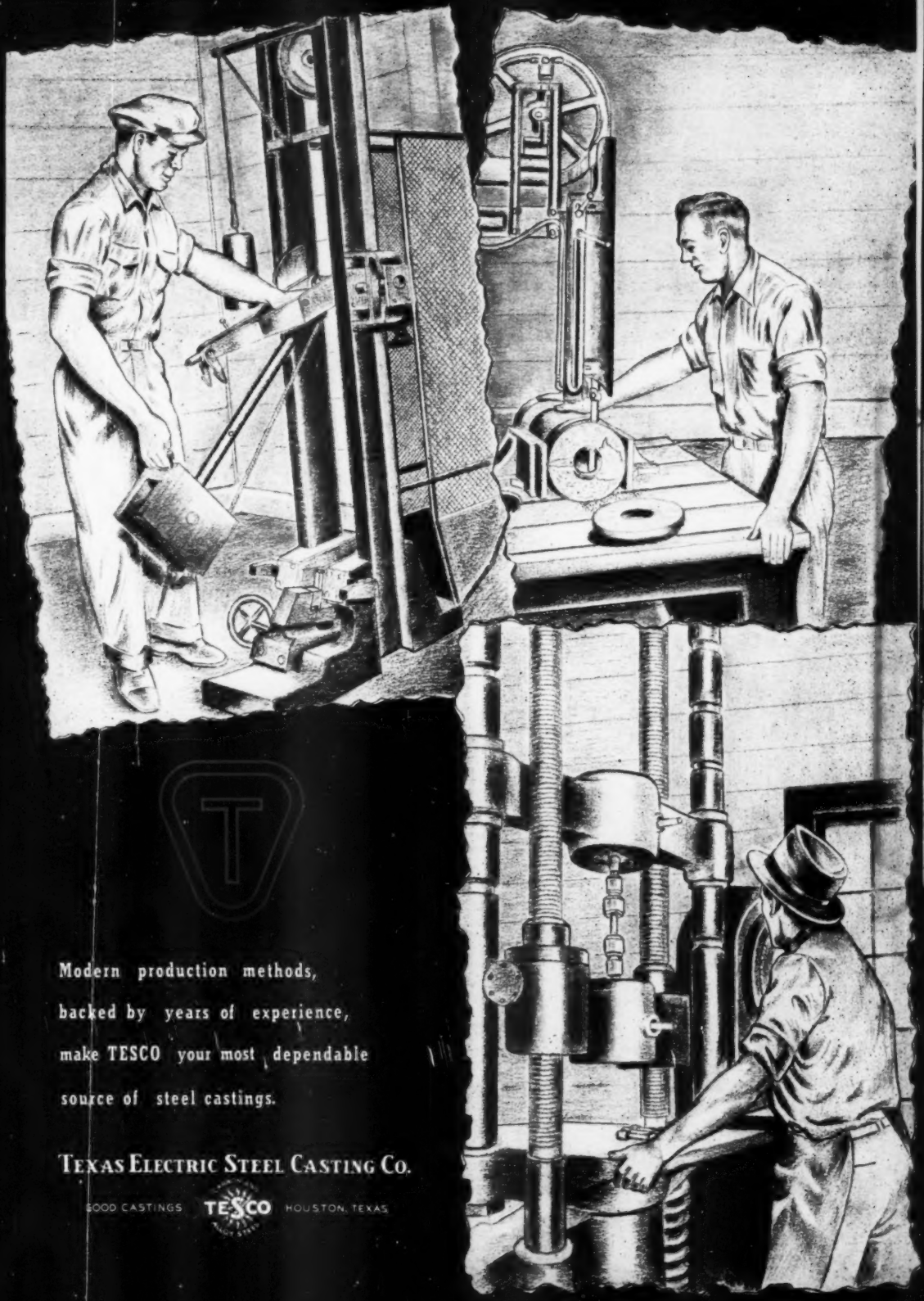

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HERE'S AN EXAMPLE of how Armstrong data help you select the right size trap for the job:

Armstrong trap capacity figures are based on literally hundreds of tests under actual operating conditions with condensate at steam temperature. The choking effect of flash steam through the orifice as well as the back pressure created by flash steam were automatically taken into account. Actual hookups were used to allow for the effect of pipe friction.

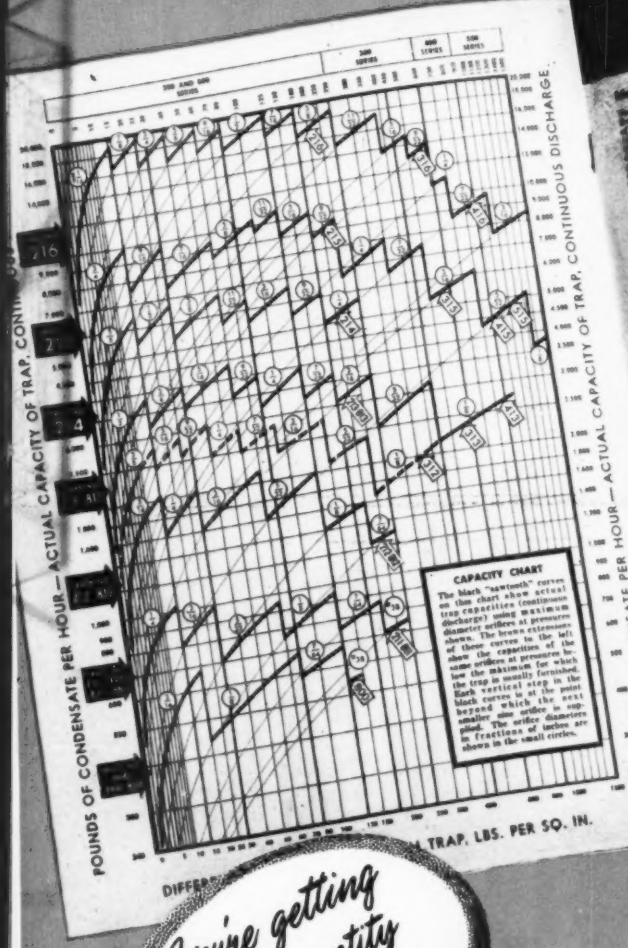
If the capacity ratings had been based on cold water tests, which produce no flash steam they would be too high.

Orifice test ratings are too high because they ignore the effect of pipe friction.

Slide rule calculations of trap capacities have never been conservative.

WHEN YOU SPECIFY A STEAM TRAP you are specifying condensate handling capacity. When you use Armstrong Selection Data and specify Armstrong traps YOU KNOW that you are getting the right trap for the job.

Armstrong traps last longer, too—with less maintenance. And, they are *unconditionally guaranteed* to give complete satisfaction.

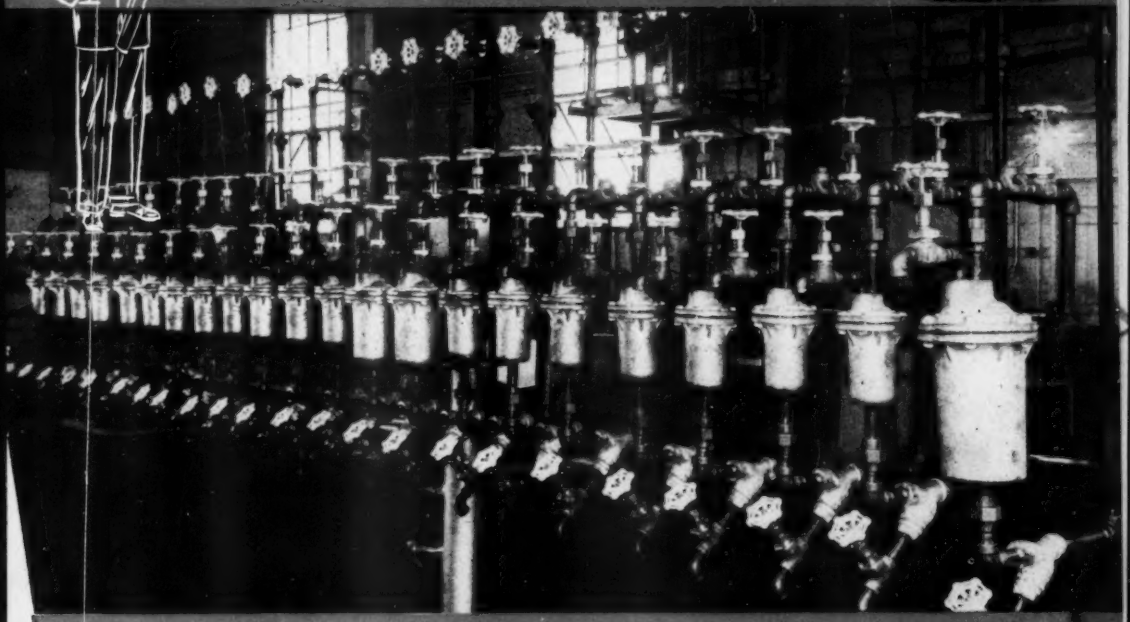

POUNDS OF CONDENSATE PER HOUR—ACTUAL CAPACITY OF TRAP, CONTINUOUS DISCHARGE
CAPACITY CHART
The black "sawtooth" curves on this chart show actual trap capacities (continuous discharge) using maximum diameter orifices at pressures shown. The brown extensions of these curves to the left show the capacities of the same orifices at pressures below the maximum for which the trap is usually furnished. Each vertical step in the black curves is at the point beyond which the next smaller size orifice is supplied. The orifice diameters in fractions of inches are shown in the small circles.
TRAP, LBS. PER SQ. IN.
Don't Forget—
When using the Capacity Chart for selection of the correct size trap for your job:
1. First determine pressure differential across trap—see page 21.
2. Determine as accurately as possible the condensate load in pounds per hour—see pages 21 and 24-34.
3. Use the correct Safety Factor—see pages 23 and 24 through 34.
4. Don't skimp on trap capacity—if the required capacity falls between the capacities of two different size traps, select the larger size.

Pages 22 and 23 of the Armstrong Steam Trap Book.

You're getting a known quantity when you specify

ARMSTRONG

No trial and error on that job . . . .
ARMSTRONG TRAP DATA are Reliable



THE most carefully calculated installation of steam-heated processing equipment will fail to deliver full output if the steam traps do not have adequate condensate and air handling capacity. When this happens an important part of the capital investment in plant and equipment is wasted.

After you have figured the amount of steam that will be condensed, you need data on:

Condensate Capacity—not theoretical, not estimated, not cold water, but actual test findings with traps discharging condensate at steam temperature (see the discussion on the left-hand page).

Trap Capacity Safety Factors, or ratio between continuous discharge capacity and actual amount of condensate to be handled. These may run from a low of 2 to 1 or as high as 8 to 1. Armstrong data tells you just what safety factor to use to obtain adequate air venting capacity and maximum heat transfer.

Armstrong trap data helps you get traps "big enough" for the job, but not too big; assures you maximum operating efficiency; eliminates corrections after installation. For traps and trapping assistance call your nearby Armstrong Factory Representative.

ARMSTRONG MACHINE WORKS
868 Maple St., Three Rivers, Michigan

Left—Side inlet—Side outlet traps for pressures to 250 lbs. for sizes.

Right—Forged steel traps for pressures to 1500 lbs. screwed, socket weld or flanged connections.

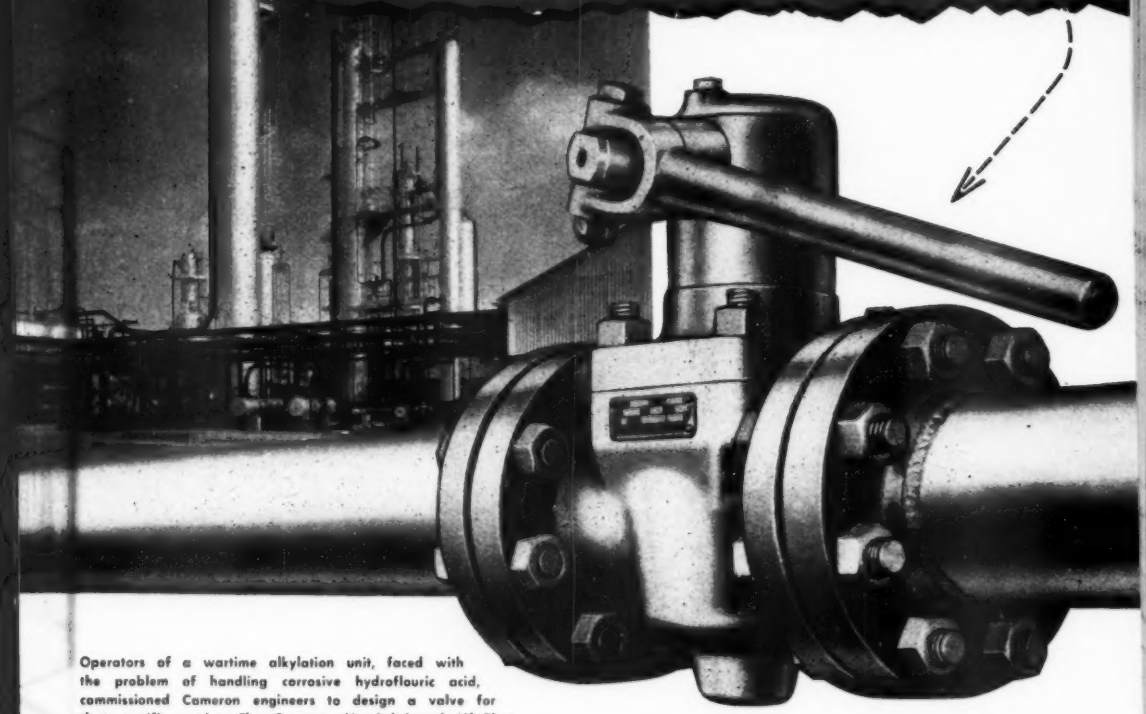
Left—Bottom inlet—Top outlet traps for pressures to 250 lbs. Six sizes.

Send for the NEW 44-page Steam Trap Book—
Including 14 pages of data on how-to size traps for nearly every type of equipment. Free on request—no obligation.

STEAM TRAPS

planning an alkylation unit?

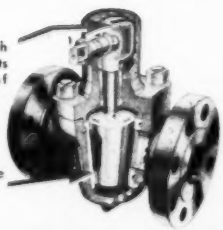
This valve was tailor-made for you!



Operators of a wartime alkylation unit, faced with the problem of handling corrosive hydroflouric acid, commissioned Cameron engineers to design a valve for that specific service. The Cameron Non-Lubricated Lift-Plug Valve is the result. It combines the best features of conventional valves with such innovations as a separate, renewable seat and a unique plug actuator which, in ¾-turn of the operating lever, lifts the plug free of the seat, then rotates the plug to open or closed position, and reseats the plug. The separate seat not only permits any desired trim for specific services and facilitates maintenance of the valve, it also provides a seat for the plug which does not distort with the body due to line strains. Consequently, no lubricant is required either to effect a seal or for easy operation.

Test-operate a few of these great valves in your own plant in your most difficult services . . . elevated temperatures, vacuum, high pressures, or corrosive products . . . and get first-hand information on their superior design.

the Cameron NON-LUBRICATED LIFT-PLUG VALVE



Plug actuator which lifts, turns, and seats plug in ¾-turn of operating lever.

Separate, renewable seat.

Cameron IRON WORKS, INC.
P. O. BOX 1212
HOUSTON, TEXAS

Export Office: 74 Trinity Place, New York, N. Y. ● Sterling Area: British Oil Field Equipment Co., Ltd., Duke's Court, St. James's, London S.W.1, England. ● California: Cameron Iron Works of California, Box 267, Long Beach. ● Canada: Cameron Iron Works of Canada, Ltd., 9860-88th Ave., Suite 3, Edmonton, Alberta.

SELLING THROUGH SUPPLY STORES

ANOTHER AMERICAN® ADVANCE

NEW TEFLON SEAL STUFFING BOX FOR HIGH PRESSURE ORIFICE METERS

Pressures to 10,000 psi.
Temperatures to 450°F.

Combining

- MAXIMUM ACCURACY
- MINIMUM FRICTION
- NO LUBRICATION
- NO LEAKAGE
- NO SHAFT FREEZING

New Accuracy! New Efficiency!

This new Type "B" stuffing box extends the benefits of Teflon to heavy-duty high-pressure American Westcott orifice meters — long noted for *simplicity of design, extreme accuracy* and *trouble-free,* dependable service.

The Teflon seal forms a packing and bearing around a precision-made Monel metal shaft of increased diameter for greater rigidity. It is pressure tight, nearly frictionless, *requires no lubrication* and reduces maintenance to a minimum. Other parts are corrosion resistant stainless steel. An external guard protects against shaft damage. The new stuffing box is suited to ambient meter temperatures to 450°F. and pressures to 10,000 psi.

The Teflon bearing and all other stuffing box parts can be removed and replaced in the field. Units are adaptable to older types of American Westcott orifice meters now in service. Write for complete details.

Another example of American's policy of constant product improvement, upholding a century-old tradition of "Sustained Accuracy at Lower Cost."

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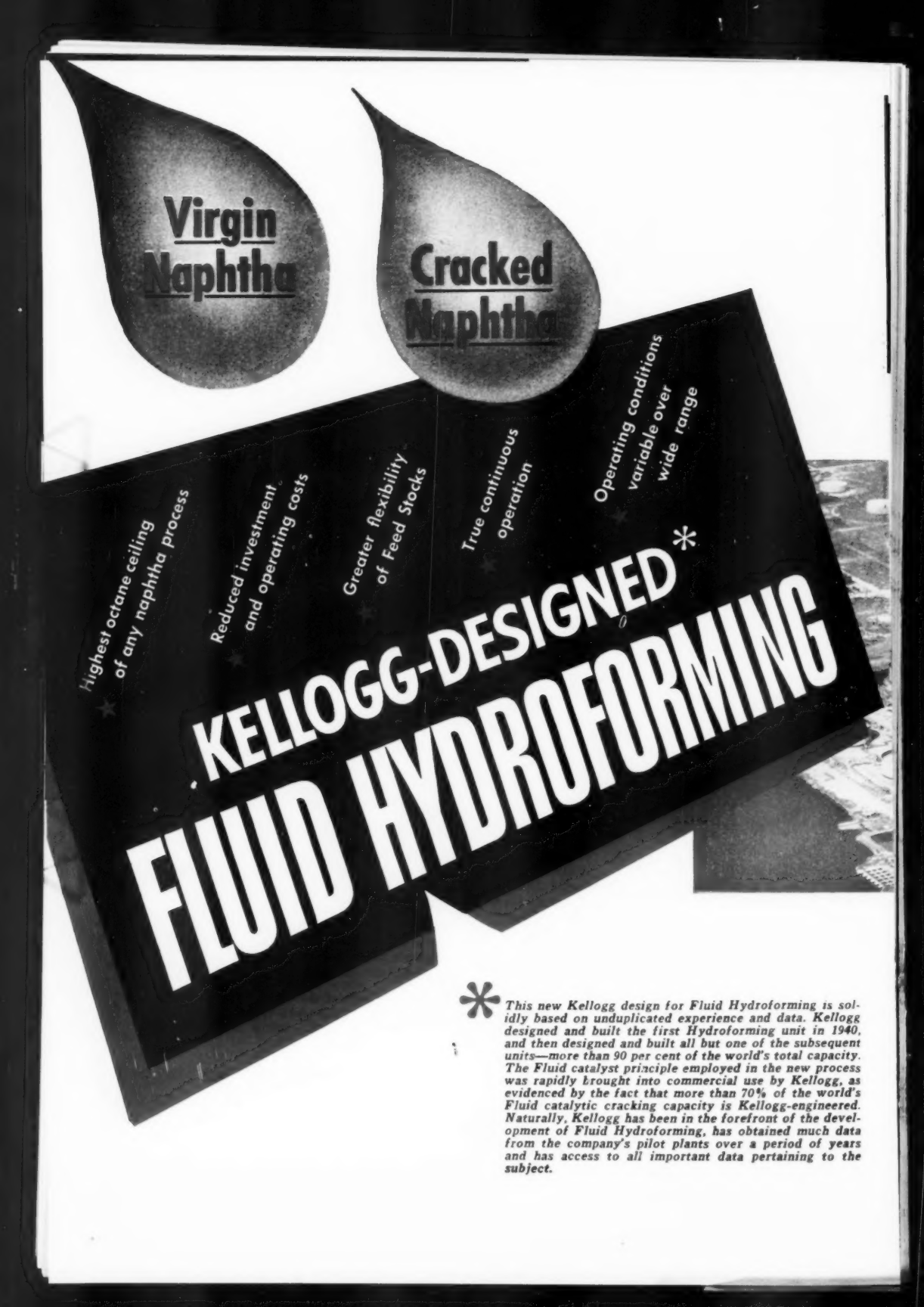
AMERICAN METER COMPANY
EST. 1836
MEASUREMENT ENGINEERS

AMERICAN METER COMPANY
INCORPORATED (ESTABLISHED 1836)



* *This new Kellogg design for Fluid Hydroforming is solidly based on unduplicated experience and data. Kellogg designed and built the first Hydroforming unit in 1940, and then designed and built all but one of the subsequent units—more than 90 per cent of the world's total capacity. The Fluid catalyst principle employed in the new process was rapidly brought into commercial use by Kellogg, as evidenced by the fact that more than 70% of the world's Fluid catalytic cracking capacity is Kellogg-engineered. Naturally, Kellogg has been in the forefront of the development of Fluid Hydroforming, has obtained much data from the company's pilot plants over a period of years and has access to all important data pertaining to the subject.*

True Continuous Operation . . .

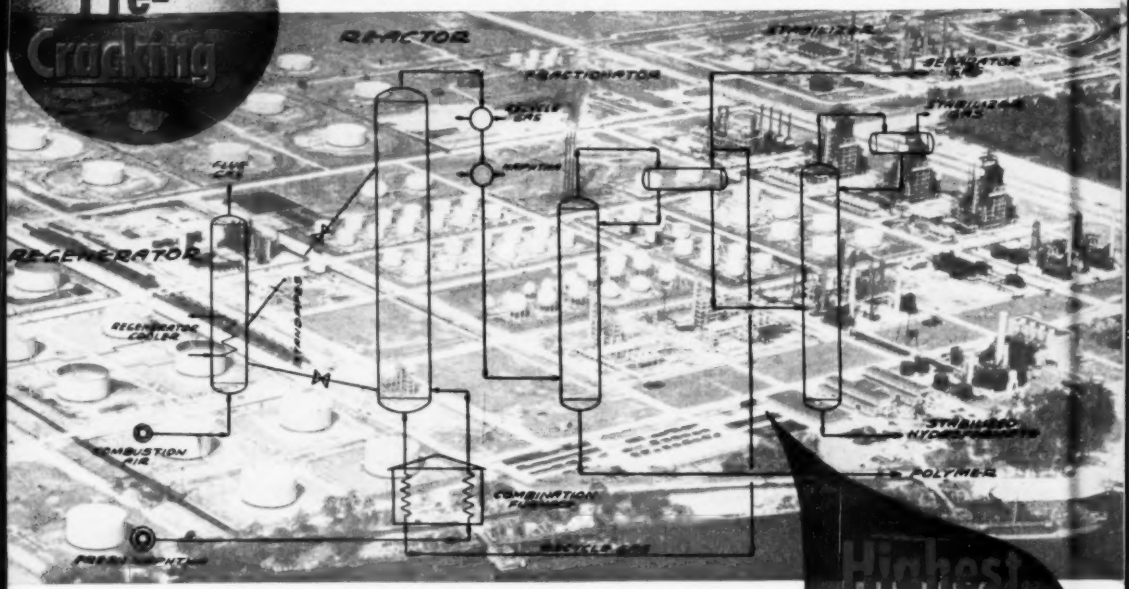
Reduced Pre-Cracking

A truly continuous process, *Fluid* Hydroforming stands today as possibly the most important single refining development since Fluid catalytic cracking.

Fluid Hydroforming offers the refiner a naphtha upgrading process at considerably reduced investment cost in comparison with conventional fixed-bed reforming processes. Its operating cost is lower. But probably most important is the fact that Kellogg Fluid Hydroforming has a higher octane "ceiling" than any other process of its kind, principally because of its continous regeneration feature.

Fluid Hydroforming is adaptable to a wider range of feeds than other naphtha processes. Feed stocks ranging from hexane (for benzene production) to kerosene can be employed if desired.

The process can be employed effectively to upgrade virgin heavy naphthas, and is especially effective on high-sulfur cracked naphthas or a mixed virgin and cracked feed.



Highest Octane Ceiling

New Kellogg-Designed Fluid Hydroforming Units in Work

- ★ **2,000 BPD UNIT** for Gulf Coast refiner to upgrade straight run naphthas to produce aviation stock
- ★ **10,000 BPD UNIT** for mid-western refiner to upgrade mixture of virgin naphthas with alternate operation on pooled refinery naphthas
- ★ **20,000 BPD UNIT** for second Gulf Coast refiner to upgrade mixed virgin naphthas

For additional information, write for "Fluid Hydroforming", which gives detailed data on the performance, yields and octane ceilings of the process.

THE M. W. KELLOGG COMPANY

(SUBSIDIARY OF PULLMAN INCORPORATED)

for fifty one years an integral part of petroleum refining progress!

KELLOGG

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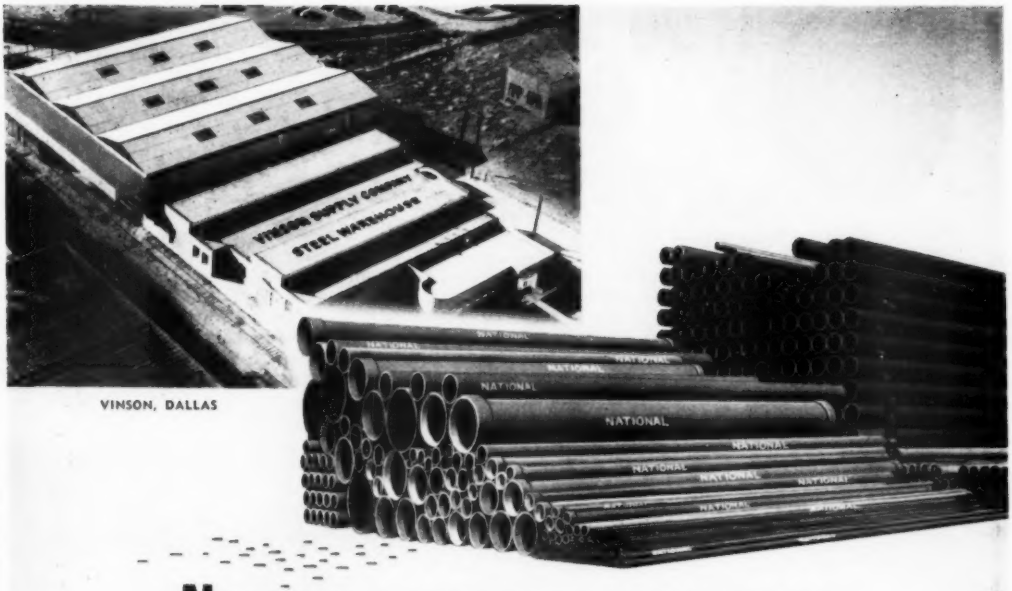

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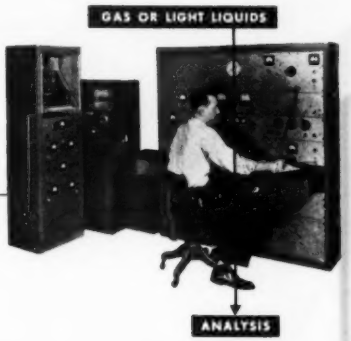

A complete, accurate analysis of a complex chemical mixture can now be made by one operator in minutes instead of hours or even days with the Model 21-103 Consolidated Mass Spectrometer.

The mixture being analyzed may be composed of organic or inorganic compounds. Virtually any gas or liquid sample may be handled so long as the individual components in the mixture exert a minimum vapor pressure of 250 microns at room temperature. Trace impurities constituting as little as 0.001 mole per cent of the mixture can be determined.

Speed and accuracy of analysis, together with versatility, make this the ideal instrument for the chemical industry. For further information on the Model 21-103, write for Bulletin CEC-1800B.

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analytical mass spectrometer

analytical service *—analysis by mass spectrometry is offered to those whose quantity of samples does not justify the purchase of an instrument. For costs, handling of samples and other details, write for Consolidated's Analytical Service Bulletin.*

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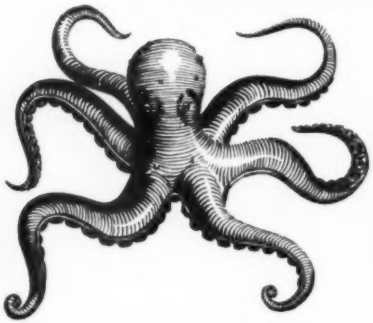

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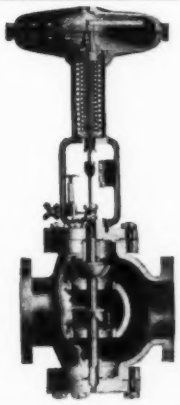
76 BS&B CLIMAX CONTROLS CENTERS



CLIMAX TYPE 86
Diaphragm Control Valve. One of the most widely used controls in the Climax line.

Your Fastest, Most Efficient Service

In 29 states and 3 Canadian provinces 76 BS&B Climax Controls sales and service centers are prepared to meet your needs for fast, efficient, convenient service on automatic controls for regulating flow, levels, temperature, pressure and power. From these centers, including 43 strategically located warehouse stocks of Climax Controls and parts, Climax sales engineers are quickly available to render service on existing equipment or to help you plan new installations.

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Climax Controls catalog will be sent to you promptly at your request.

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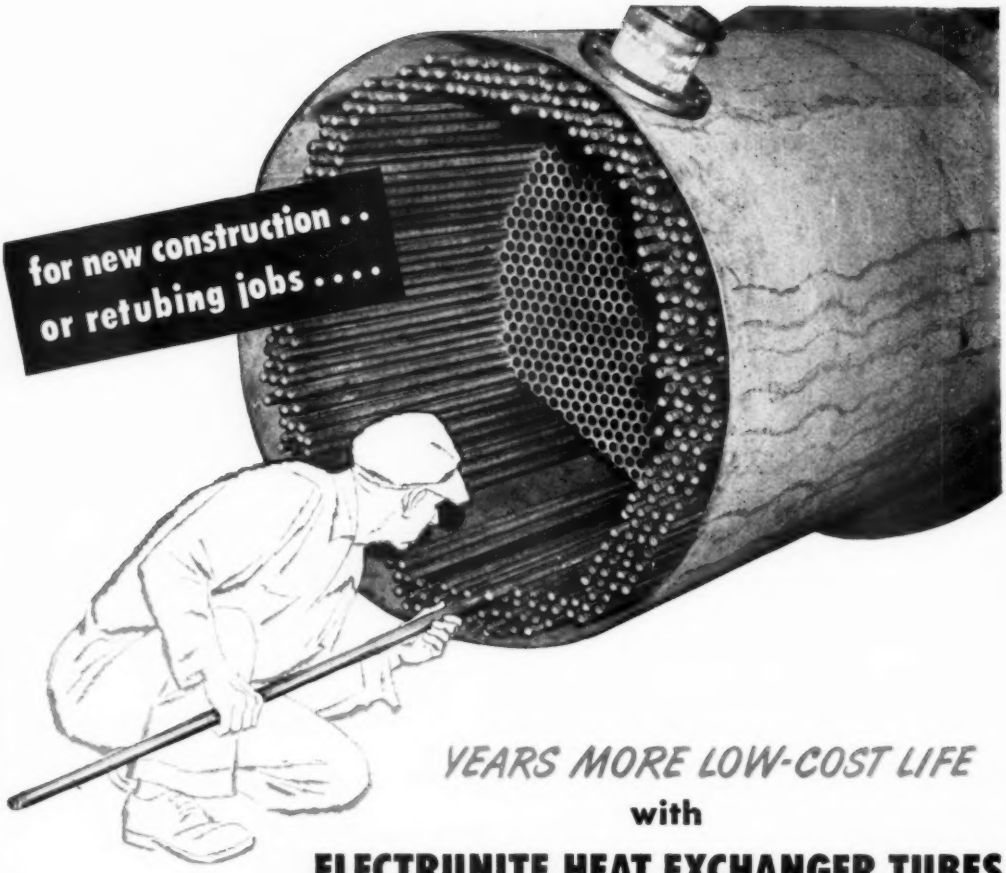
Climax Controls Division Dept. 4-A3

7500 E. 12th Street — Kansas City, Missouri

Climax Controls Factory: Tulsa, Oklahoma — *Oil & Gas Equipment Div: Oklahoma City, Oklahoma*



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ELECTRUNITE HEAT EXCHANGER TUBES

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Fully-normalized structure provides uniform ductility for fast, smooth roll-in of ELECTRUNITE Tubes. Cold forming gives them clean, scale-free surfaces that assure maximum service life. Choose from a wide range of sizes and grades, in carbon steel and stainless steel analyses. For complete data and information, write to

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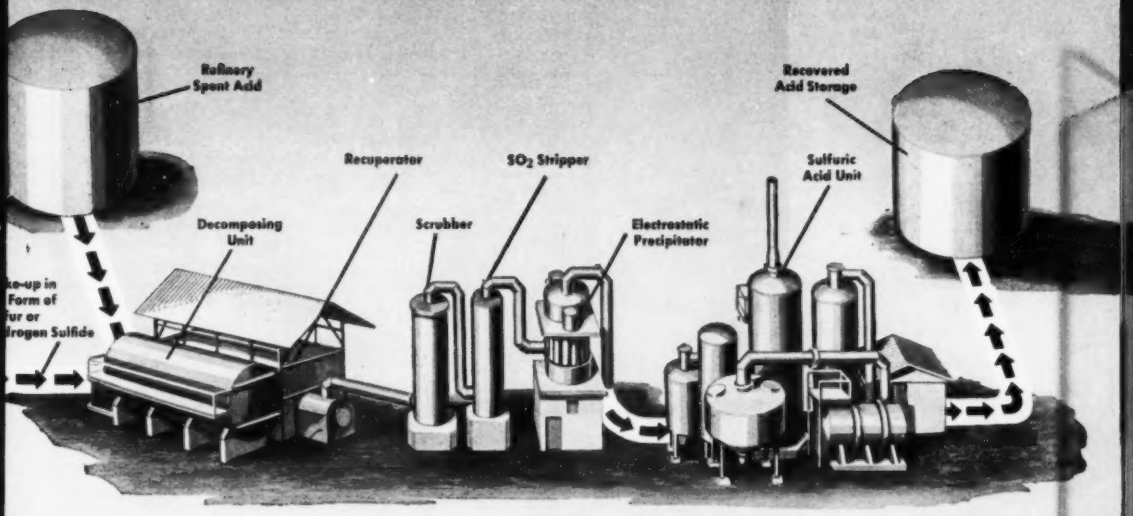
CHEMICO OFFERS AN ECONOMICAL PROCESS FOR

Spent Alkylation Acid Regeneration



*D*ue to the increased cost of brimstone and the vital need to conserve basic sulfur deposits, petroleum refiners producing high octane aviation gasoline will find it desirable to recover the sulfuric acid from their spent alkylation acid. For this purpose, Chemico offers a proven and economical process.

In this process, spent alkylation acid—now in greater supply as a result of the increased manufacture of high octane gasoline—is sprayed into a furnace maintained at a high heat with auxiliary burners. Sulfur or hydrogen sulfide may be used as fuel thereby producing SO_2 gas for the production of make-up acid.

A limited amount of other liquid acid sludges, high in hydrocarbon content, may also be added to the alkylation spent acid, thus providing fuel as well as additional acid production. The hydrocarbons are completely consumed and the acid is broken down into its components—sulfur dioxide, oxygen and water. After the water is removed, the gas is processed to fresh acid of 98% strength in a Chemico contact sulfuric acid unit. Send for additional information, stating your requirements.

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Chemico plants are profitable investments

CC 211

INCREASE REFINING CAPACITY

without adding a single piece of major refining equipment

A survey of 43 leading refiners who desalt with Petreco disclosed that the charging of clean, salt-and-solid-free crude pays out quickly — *in increased refining capacity.* *

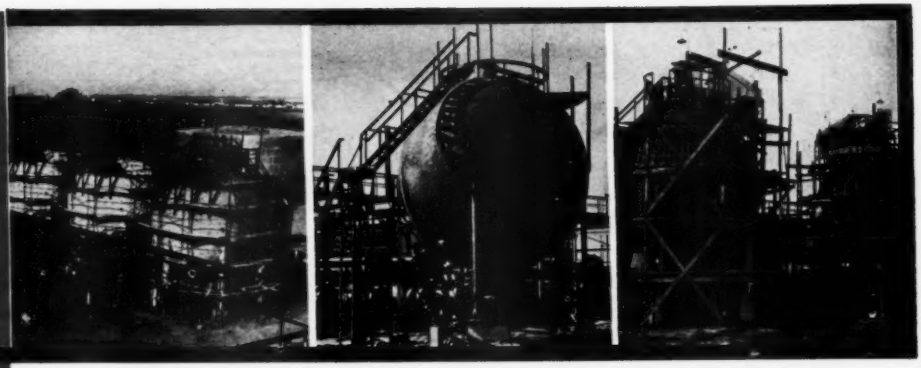
The object of this survey was to find out exactly what benefits were derived from Petreco *high-efficiency desalting*. The results, showing *where, how* and *how much* Petreco desalting helped, are shown in the table below.

TYPE OF REFINING UNIT	NUMBER OF REFINERIES COVERED	OPERATION OR FACTOR IMPROVED	AVERAGE DEGREE OF IMPROVEMENT AFTER DESALTING
TOPPING AND COMBINATION	29	Temp. to Tower	21°F INCREASE
	35	Length of Runs	204% INCREASE
	38	Charging Rate	21.3% INCREASE
	21	HCl Corrosion (Estimated)	75% DECREASE
CRACKING AND COMBINATION	17	Temp. Black Oil Coil	17°F INCREASE
	22	Length of Runs	136% INCREASE

Benefits such as those shown above are reflected in improved service factors at refineries utilizing Petreco Desalters. One refiner in Ohio cites an increase in service from 65% before desalting to 85% after desalting; another from 84% to 95.5%; another from 79.9% to 89.3%. Such improvements pay out in simple, basic, operating advantages — *more barrels of crude refined per calendar day.*

* ***In one refinery the technical staff made a thorough economic analysis covering the cost of operating one combination unit — before, and after — desalting with a Petreco Electrosphere. Their computations were based on plus factors such as increased crude charge rates, savings in maintenance and increased vis breaking; the minus factors were based on the cost of Petreco processing plus the cost of utilities, maintenance and depreciation. Income tax was deducted from the gains accruing from Petreco Desalting — yet their computations disclosed that the Petreco Desalting unit had shown a payout of about 12 weeks! Petreco engineers are fully conversant with the many economic benefits of high-efficiency desalting — they will be glad to cooperate with your engineers on a cost-of-salts analysis for your refinery.***

MORE PETRECO DESALTERS ARE UNDER CONSTRUCTION THAN EVER BEFORE.



PETRECO OFFERS SERVICE FACILITIES UNEQUALLED IN THE FIELD OF DESALTING.

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SPECIALIZED *Electric* PETROLEUM PROCESSES { DESALTING / DEHYDRATING

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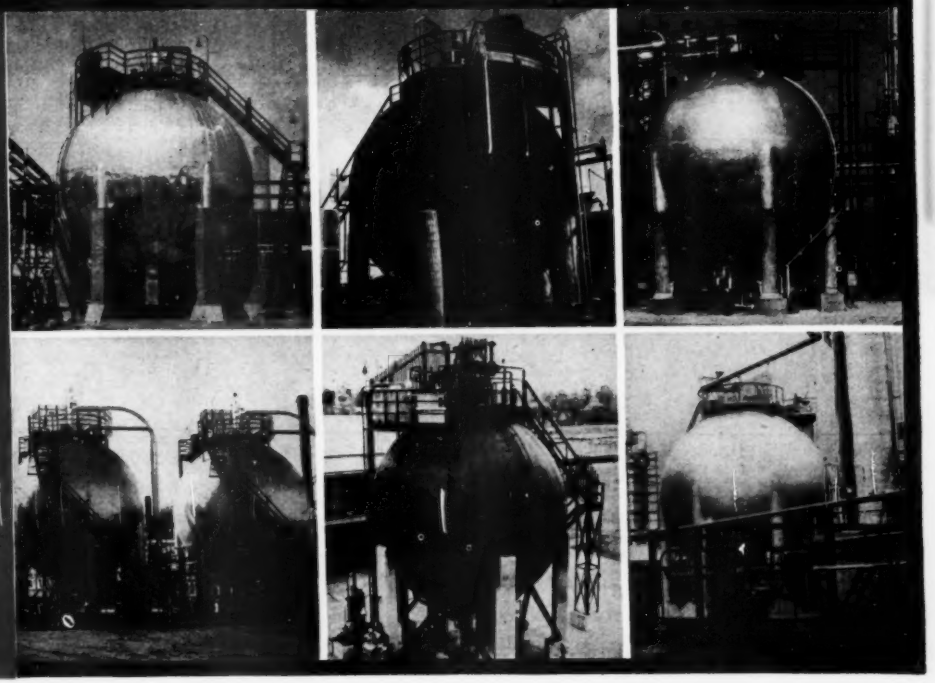
MORE PETRECO DESALTERS ARE NOW IN USE THAN EVER BEFORE.



SPEED ADVANCEMENT

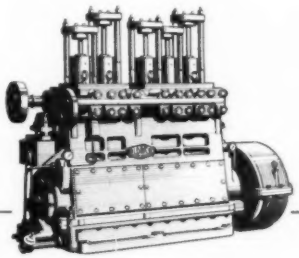
Aldrich did it with Direct Flow Pumps

Not too long ago, 150 rpm was considered high speed operation for reciprocating pumps. But today—as a result of improved design and stronger metals—Aldrich Direct Flow Pumps are operating efficiently at *or over* speeds of 500 rpm for the 3″, 360 rpm for the 5″, and 300 rpm for the 6″ stroke unit. This increase in speed means simply this:

You get more work—greater pressure and volume—out of a smaller pump. You invest in a lighter, lower cost unit . . . a pump with a *sectionalized* fluid-end that's extremely easy to maintain and which can be made of stainless steel, bronze, Monel or other special material, as desired.

Applications for Aldrich Direct Flow Pumps include: water flooding, salt water disposal, lean oil recycling, and the handling of diethylene glycol, gasoline, propane and butane.

Request Data Sheets on 3″, 5″, or 6″ Stroke Pumps for complete information.



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...Originators of the Direct Flow Pump

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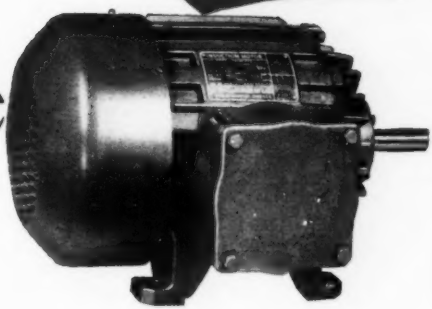
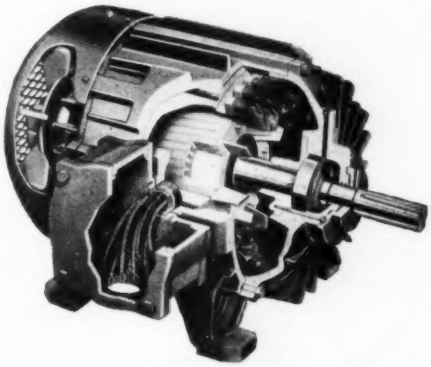
Look Outside



Greatly increased radiating area means greater cooling efficiency. More important, cooling efficiency stays high. There are no enclosed external air passages to clog and cause overheating. If oily dirt sticks, just wipe or blow it off. No matter how bad operating conditions are, this motor can easily be kept clean and cool-running. Electrical parts are protected against corrosive atmospheres by cast iron yokes and end housings.

Look Inside



Double-shielded, heavy-duty ball bearings require no maintenance in ordinary service under most conditions. However, they can be lubricated without disassembly if required. Double shielding prevents over-lubrication, leading cause of bearing trouble. Rotating seals, where shaft extends through housings, keep dirt and moisture out of bearing chambers. Deep rabbet fits between frame and end shield; heavy ribbing and long flame seals on shaft more than meet Underwriters' label requirements for Class I, Group D and Class II, Groups F and G locations.

See WHY THIS IS YOUR BEST MOTOR BUY

HERE IS AN EXPLOSION-PROOF MOTOR that is different from conventional explosion-proof motors; built with an entirely different cooling system that gives you big savings in lower maintenance costs, more continuous service and less trouble in toughest locations. Clogging can easily be prevented in the Allis-Chalmers Type APZZ explosion-proof motor since areas that might collect dirt are exposed and easy to clean. And, of course, it's ideal for outdoor installations.

GET DETAILS NOW — *Ask your nearby Allis-Chalmers Authorized Distributor or District Office for more complete information on this high performance explosion-proof motor. Or write direct to Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Bulletin 51B7286.*

A-3579

Texrope and Vari-Pitch are Allis-Chalmers trademarks.

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PUMPS — Integral motor and coupled types from ¾ in. to 72 in. discharge and up.

Yes, Chapman makes cast steel gate, globe and check valves, to ASA and API ratings . . . for all pressures and purposes and in all sizes.

So file this mental note: It pays to check with Chapman on *all* your valve requirements, standard or special. Have you the latest edition of Catalog 20 covering Cast Steel Valves? It's yours for the asking.

The CHAPMAN VALVE Manufacturing Company
INDIAN ORCHARD, MASSACHUSETTS

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Announces

the completion of its NEW
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The Quaker Oats Company's Omaha Chemical Plant is now producing the industrially important chemical, QO-Furfural. This chemical is made from raw materials such as corn cobs and oat hulls which are replaceable yearly.

The first QO-Furfural was produced at Cedar Rapids, Iowa 29 years ago. Now this versatile chemical is made not only at Cedar Rapids, but also at Memphis, Tennessee and Omaha, Nebraska.

QO-Furfural is used in refining lubricating oils, gas oil and catalytic recycle stock; extractive distillation of C_4 hydrocarbons; as a chemical intermediate in the production of nylon, furfuryl alcohol, tetrahydrofurfuryl alcohol and other chemical derivatives; as an aldehyde in resin manufacture and as a reactive solvent.

A request on your letterhead will bring you the Bulletin entitled "Current Uses of Furfural."

The Quaker Oats Company CHEMICALS DEPT.

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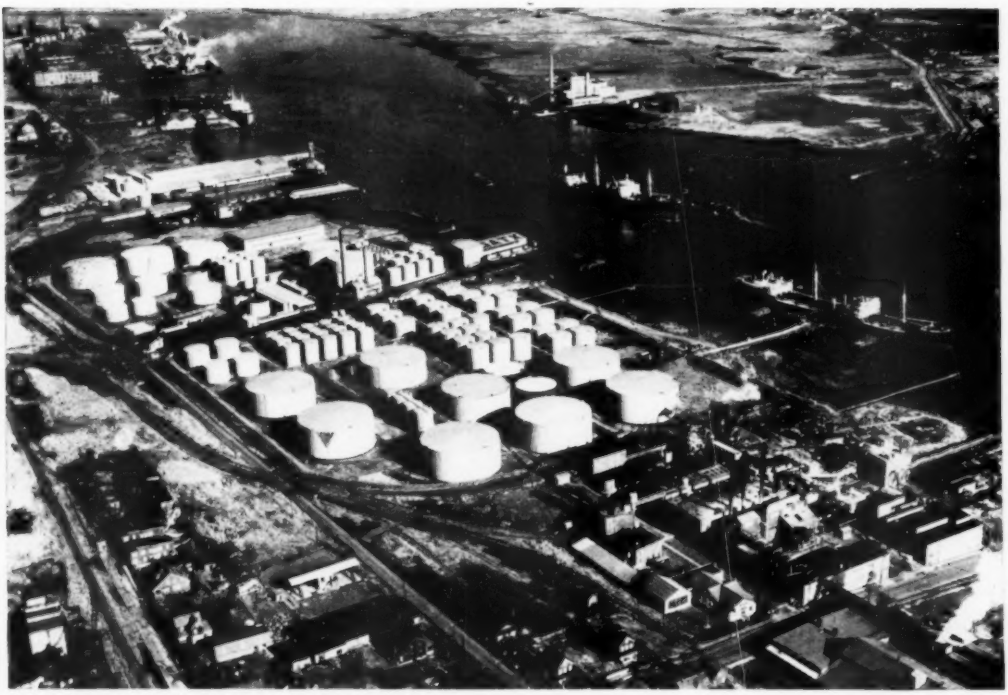
In San Francisco The Griffin Chemical Company • In the United Kingdom, Imperial Chemical Industries Ltd., Billingham, England • In Australia, Swift & Company, Pty., Ltd., Sydney • In Europe, Quaker Oats-Graanproducten N. V., Rotterdam, The Netherlands; Quaker Oats (France) S. A. 42, Rue Pasquier, Paris 8e, France
In Japan, F. Kanematsu & Company, Ltd., Tokyo



Tanks of the General American Transportation Corporation's Storage Terminal, Carteret, N. J., after being painted with Light Gray TANKHIDE.

IF IT'S TOUGHNESS AND LONG LIFE YOU WANT—USE PITTSBURGH TANKHIDE

WHEN you're looking for toughness and durability in a finish for gasoline and oil storage tanks, Pittsburgh TANKHIDE gives you what you want.

● **The combination** of special pigments and weather-resistant vehicles makes TANKHIDE an unusually durable, long-lasting metal protective paint. The ability of TANKHIDE to reflect heat prevents excessive losses caused by evaporation. Not only are evaporation losses prevented but TANKHIDE'S original appearance is maintained for a long time by its unique self-cleaning action.

● **TANKHIDE** is designed to hide thoroughly with one coat, whether sprayed or brushed on.

● **For many years TANKHIDE** primers and finishing coats have been used most satisfactorily in all sections of the country to protect millions of tons of iron and steel in structures, equipment and machinery.

● **Besides TANKHIDE,** Pittsburgh also offers a complete line of protective coatings for every need in the petroleum industry—production and refinery finishes for towers, pipe lines, buildings and equipment; service and bulk station paints; pump enamels and drum finishes.

● **Call on us** for expert advisory service. Our wide experience in supplying finishes to the petroleum industry can be helpful and often save you time and money.

• • •

PITTSBURGH PLATE GLASS COMPANY

Industrial Paint Division, Pittsburgh, Pa.
Factories: Milwaukee, Wis.; Newark, N. J.; Springdale, Pa.; Houston, Texas; Los Angeles, Calif.; Portland, Ore. Ditzler Color Division, Detroit, Mich. The Thresher Paint & Varnish Co., Dayton, Ohio. Forbes Finishes Division, Cleveland, Ohio. M. B. Suydam Division, Pittsburgh, Pa.

PPG

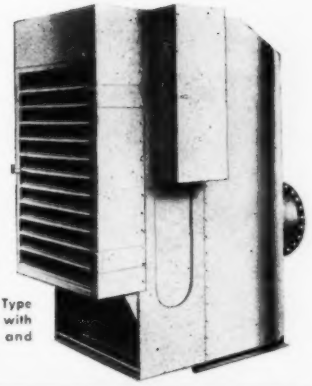
PITTSBURGH PAINTS

PAINTS • GLASS • CHEMICALS • BRUSHES • PLASTICS

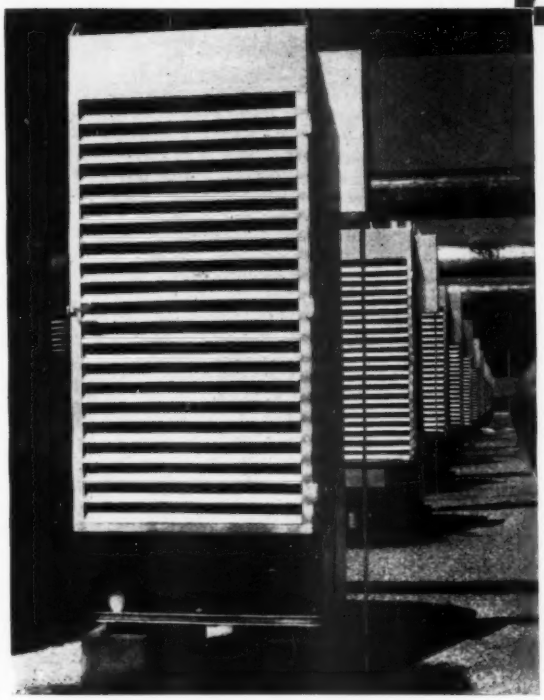
PITTSBURGH PLATE GLASS COMPANY

A "MUST" Where There's Dust

Constant efficiency, uniform air delivery—AAF Multi-Duty Air Filters give you both automatically



Typical Multi-Duty Type CMS Filter equipped with weather louvers and plenum chamber.



Fifteen 2400 H. P. Cooper-Bessemer compressors make up this Hanford, Texas, unit of the Michigan-Wisconsin Pipe Line. Farsighted planning saw to it that dust protection was a part of the basic installation. Recognition of proven field performance resulted in the logical specification—AAF Multi-Duty Type CMS Air Filters.

The Type CMS washes its face regularly without the "mother care" of a maintenance man. Because cleaning of its overlapping panels is both automatic and continuous, high efficiency is maintained regardless of dust load, and uniform air delivery results at all times. Periodic inspection and regular sludge removal (without shutdown) are all that's required to keep this filter in fighting trim the year 'round.

For outdoor living, filters come equipped with protective weather louvers and a plenum chamber for attachment of intake. This chamber also has a perforated metal baffle which dampens intake pulsations and distributes air uniformly over the entire filter curtain area.

If you want to write off the threat of dust, permanently, write in the AAF Multi-Duty Type CMS in your next air filter specifications.

Write for Bulletin No. 150.

Today's Best Buy is Better Air!

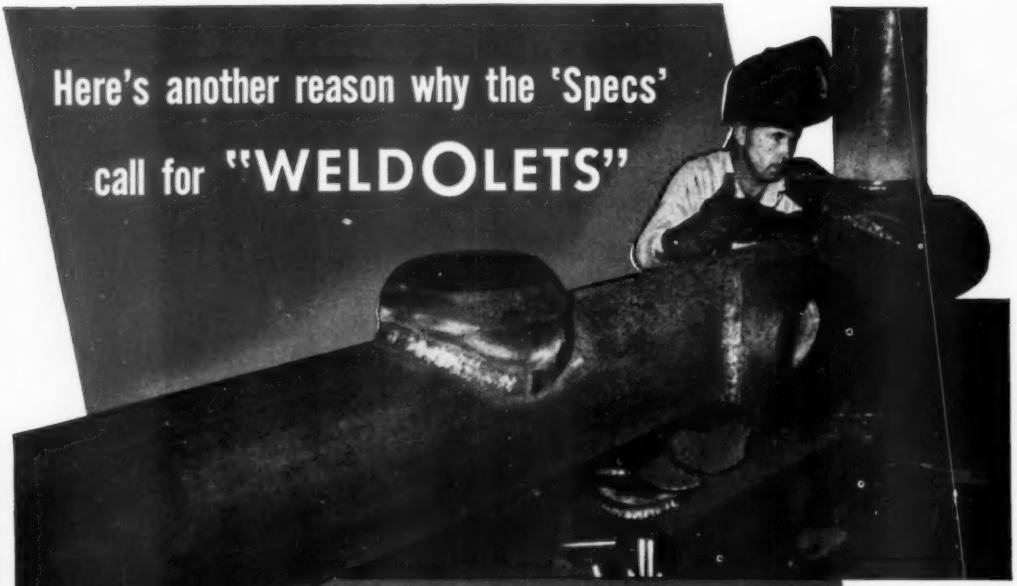
AAF

American Air Filter

COMPANY, INC.

444 Central Avenue, Louisville 8, Kentucky • American Air Filter of Canada, Ltd., Montreal, P. Q.

Here's another reason why the 'Specs' call for "WELDOLETS"



Extra strong WeldOlets, butt-welding, utilized to make fully reinforced branch connections in Gas Measurement Headers to operate at 1000 psi.

LET'S COMPARE THE PLUS FEATURES OF WELDOLETS AGAINST REINFORCING RINGS OR PADS

1. The WeldOlet is a Welding Fitting rather than a hand-made reinforcement of a hand-made joint. It is both a mechanical and a pressure member.

2. The self-aligning, shaped and beveled WeldOlet is equally adaptable for shop or field fabrication. Its employment eliminates the need for additional reinforcement.
3. Production economy is realized by employment of WeldOlet construction which speeds up installation time in both shop and field fabrication. Only two welds are required to install WeldOlets.
4. The WeldOlet type of construction inherently provides sufficient reinforcement in accordance with Code requirements to meet or surpass the maximum services of whatever weight pipe is used. To facilitate determination of where it is necessary to reinforce or to use a WeldOlet, the new Bonney catalog W-3 features time-saving data on this subject.
5. Dimensional advantages of WeldOlets allow closer manifolding and cross combinations and provide improved flow conditions.

1. Precious pipe is wasted in making reinforcing rings or pads.

2. Reinforcing rings can be cumbersome to handle and clumsy to fit in both shop and field fabrication.
3. Excessive welding is necessary to complete branch reinforcing requirements according to Code provisions when rings or pads are used. Three separate welds are required. This slows down piece production time in both shop and field fabrication.
4. Lengthy calculations are necessary to determine the amount of reinforcing required when designing for ring or pad reinforcement.

The Bonney Catalog No. W-3 will show you why WeldOlet Welding Fittings offer the quickest, safest and most economical method of establishing and maintaining 100% pipe strength at branch connections in accordance with Code provisions. Write for your free copy.

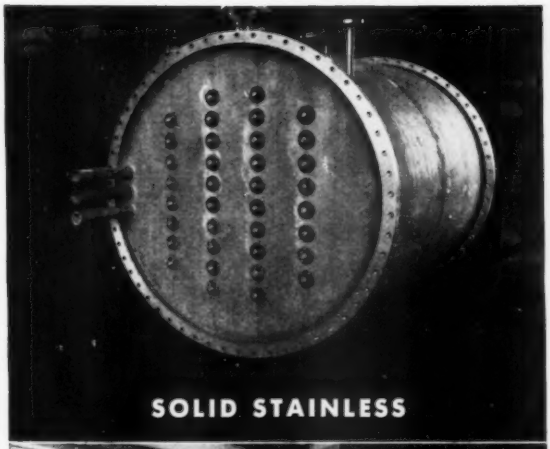
CANADIAN REPRESENTATIVE
Sterling Steel Co., Ltd.
267 Davenport Road
Toronto 1, Canada

EXPORT DISTRIBUTOR
National Supply Co. Export Div.
600 Fifth Ave., New York 20, N.Y.

WELDING FITTINGS DIVISION

BONNEY FORGE & TOOL WORKS

306 GREEN STREET, ALLENTOWN, PENNSYLVANIA



SOLID STAINLESS

STAINLESS-CLAD

GRAVER TOWERS

IN STEEL AND ALLOYS FOR EVERY PROCESS REQUIREMENT

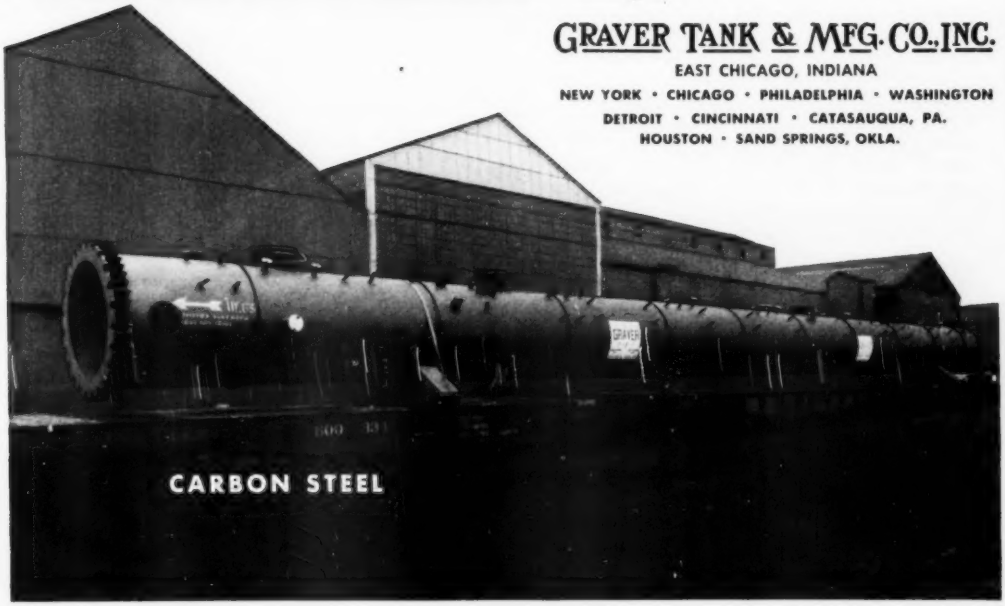
Here are excellent examples of Graver's ability to satisfy the diverse requirements of the petroleum and process industries. Fabricated to conform with standard codes or special requirements, these towers are the result of Graver's long experience in manufacturing quality vessels in steels, clads and alloys.

The wide variety of processing plants in which these intricately designed towers and columns are operating today attests to Graver's versatile craftsmanship and indicates why Graver has long been a prime source of supply in this exacting field.

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

NEW YORK • CHICAGO • PHILADELPHIA • WASHINGTON
DETROIT • CINCINNATI • CATASAUQUA, PA.
HOUSTON • SAND SPRINGS, OKLA.



CARBON STEEL

There's a LORAIN to Put Pipe Any Place

UP HIGH...

DOWN DEEP

Lorain Cranes — on crawlers or rubber-tires, convertible to dragline or clamshell can handle scores of lifting, loading and excavating jobs. Available in capacities from 6 to 45 tons.

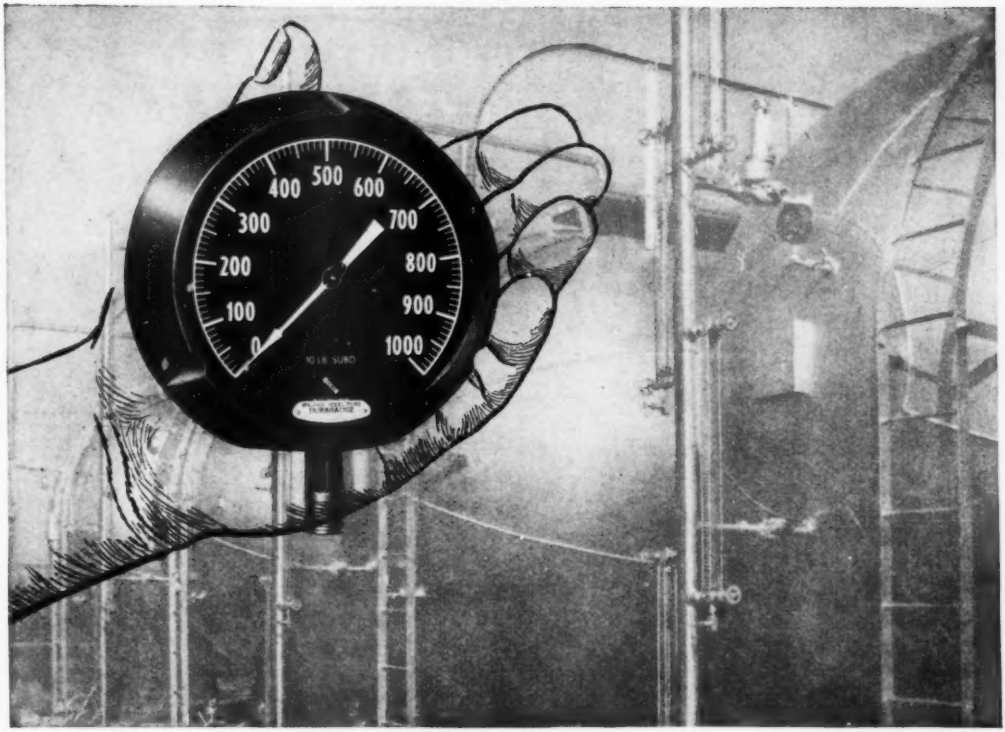
■ Overhead . . . or underground . . . you can solve your pipeline problems with efficient Lorain cranes-shovels. Here are two operations familiar to the petroleum industry. At a large California refinery a Lorain TL25-J crawler crane is used for every kind of job . . . from transporting and erecting miles of pipe to loading and moving large winches and other heavy machinery. This owner gains extra savings on extra jobs with this fully convertible, all-purpose ¾ yd. Lorain.

For cross-country pipelines, there is no hoe to match the Lorain Pipeliner for ditching operations. Whether it's production, transmission, or refining, there is a Lorain model, mounting and front end that will exactly fit your needs. Any of the 125 Thew-Lorain distributor outlets across the country can give you detailed information.

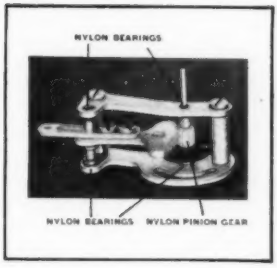
THE THEW SHOVEL CO., LORAIN, OHIO

Lorain Pipeliners — for cross-country ditching — are designed with exclusive features for the pipeline industry — including extra-wide crawlers for straddling ditches. Also draglines, clamshells on crawlers or rubber-tires.

THEW ® LORAIN PIPELINER



Outlasts ALL OTHERS!



Since the introduction of the Nylon Movement* in 1947, the Ashcroft Duragauge has set new standards for pressure gauge performance in the most "killing" services.

Here's why: All worthless weight and mass of parts is engineered *out* of the Duragauge Nylon Movement. The light, strong, dimensionally stable nylon pinion gear and bearings have low coefficients of friction. They absorb vibration and pulsation—resist wear—far better. All this adds up to sustained accuracy, improved sensitivity, lower maintenance and longer service life.

Whether you refine petroleum, generate electricity, process chemicals or anything else demanding accurate pressure indication or recording to insure safety, product quality, or cost control – install Ashcroft Duragauges. Your nearby Ashcroft Distributor will gladly help you select the right Ashcroft Duragauge for your specific needs.

*Patented

1850 ASHCROFT U.S.A.

ASHCROFT GAUGES

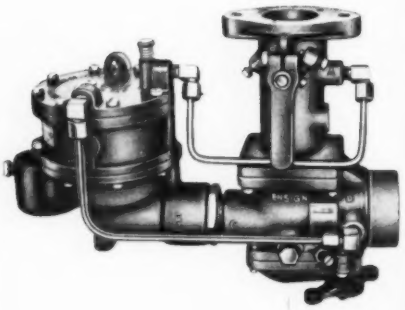
MANNING MAXWELL & MOORE

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'ASHCROFT' GAUGES, 'HANCOCK' VALVES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, BUILDERS OF "SHAW-BOX" CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

'ROUND THE CLOCK DEPENDABILITY

...Allis-Chalmers Gas Engines ENSIGN Equipped



Probably no single piece of engine equipment could so easily ruin the reputation of a good gas engine as its carburetion. By the same token the carburetor and fuel regulator go a long way to make for dependable and reliable engine performance.

Gas engines operating in the remotest parts of the world, frequently in the hands of the most inexperienced, must be easy to start, easy to operate and easy to service. Builders of engines, carburetors and other components alike know the importance of simplicity in design and high quality workmanship as an assurance of long and satisfactory field life.

Since 1911 we have built several million ENSIGN units for use on all principal makes of gas engines. We have constantly improved our products both in details of design and in selection of materials to best meet field conditions whatever they may be.

Allis-Chalmers Model "W" Gas Engines on Oil Circulating Pumps

Dealers and Distributors In All Principal Oil Fields

This advertisement is one of a series featuring popular makes of gas engines in field service.

ENSIGN

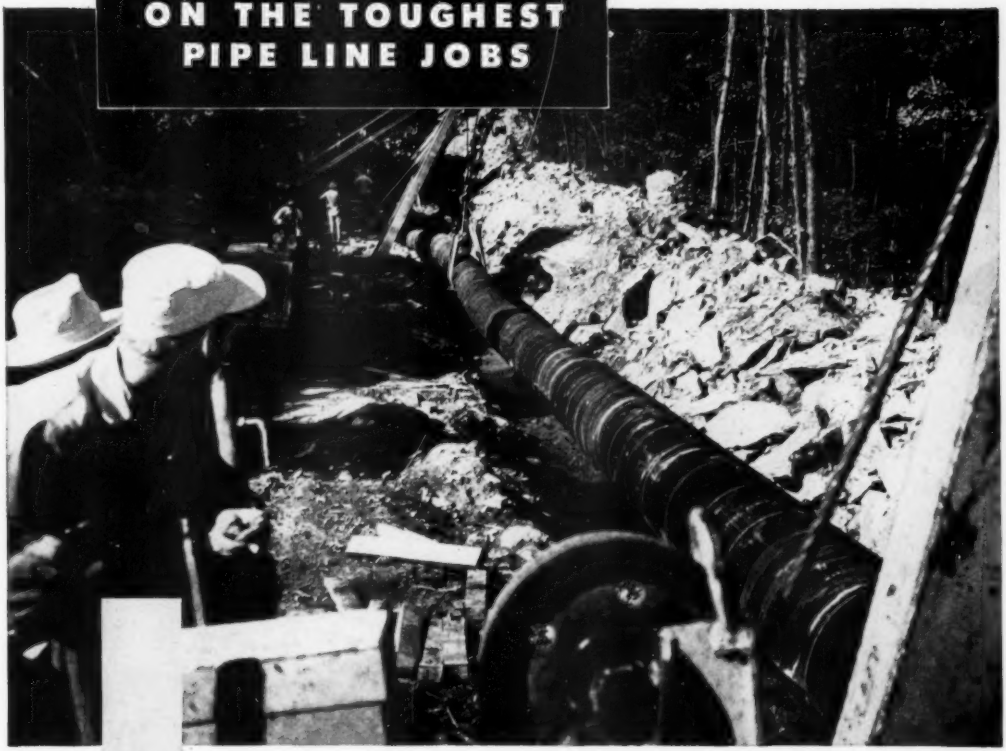
CARBURETOR COMPANY

7010 SOUTH ALAMEDA ST., P. O. BOX 229

HUNTINGTON PARK, CALIFORNIA

Branch Factory: 2330 West 58th Street, Chicago 36, Illinois

ON THE TOUGHEST PIPE LINE JOBS



C. F. & I. Welded Steel Pipe Fits Up Faster—Lowers In Easier

C. F. & I. pipe is made from high-tensile steel plates produced entirely in our own plants and quality-controlled through every phase of fabrication starting with the open hearth. Every length is hydraulically expanded for accurate size and perfect roundness... precision bevelled at the ends for time-saving, labor-saving ease of handling in the field. Available in lengths of 40 feet and in overall diameters from 24 inches through 36 inches. For detailed information, write to Claymont Steel Corporation, Claymont, Delaware.

FLANGED AND DISHED HEADS... CARBON AND STAINLESS-CLAD STEEL PLATES

CF&I

WELDED STEEL PIPE

PRODUCT OF

CLAYMONT STEEL CORPORATION

SUBSIDIARY OF THE COLORADO FUEL AND IRON CORPORATION

THERE ARE 5 POINTS *to this success story*

1. **PRECISION GEARS**—Precision generation by the famous Farrel-Sykes process, evenly distributed load, overlap or interlacing of the teeth, gradual engagement and inclined line of pressure keep power-transmission efficiency "fresh" through long years of service.

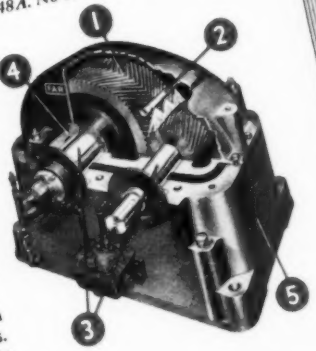
2. A **"FOUNTAIN OF YOUTH"**—The completely self-contained circulating oil system virtually puts power on "velvet" by providing a protective spray of oil at the mesh line of the gears and, at the same time, pressure-lubricating the bearings.

3. **PRECISION-GROUND SHAFTS**, extra large for the power to be transmitted, give added stiffness against bending and torsional deflections under peak loading variations.

4. **OVERSIZE SLEEVE BEARINGS** with consequent low unit pressures. Precision finished to extremely close tolerances.

5. **EXCEPTIONALLY RIGID HOUSING** holds rotating elements in original alignment, insuring maintenance of operating smoothness of the precision-generated gearing.

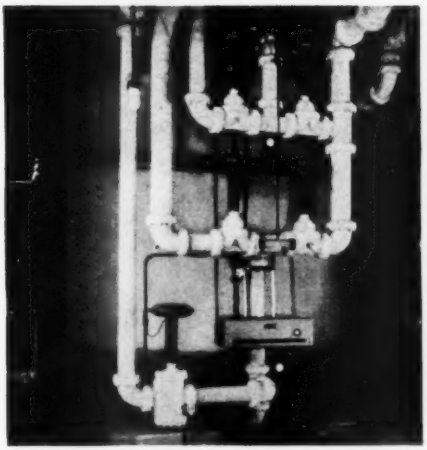
These five features account for the perfect record of Farrel speed increasers in pipeline pumping service. For further details, send for a copy of bulletin 448A. No cost or obligation.



FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.
Plants: Ansonia and Derby, Conn.; Buffalo, N. Y. • Sales Offices: Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Dallas, Chicago, Portland (Oregon), Los Angeles, Salt Lake City, New Orleans

OIL FIELD REPRESENTATIVES
Harrold-Kepler Engine Sales Co., 124 N. Rooney St., Tulsa 1, Okla.
V. W. Osborne, 840-A M&M Bldg., Houston 2, Texas

Farrel-Birmingham®



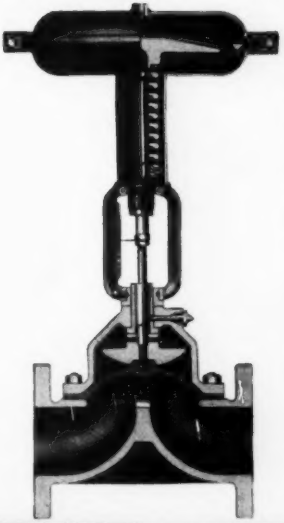
HOW K & M VALVES HELP "SOFTEN UP" 120,000 GALLONS OF HARD WATER PER HOUR

The mineral salts in hard water can cause extremely costly damage to the boilers of a power plant.

At one of America's most important industrial plants, a massive installation of cation and anion exchangers "softens up" or demineralizes water at the rate of 120,000 gallons per hour, thus protecting the steam generators.

The big exchanger units are complicated and require trustworthy regulation of flow at many points. 125 K & M Saunders-Type valves in the assembly do the job with safety, certainty and precision. Moreover, the installation has been so successful that the company is building a similar one, for which K & M valves are also being used.

Leaders in many industries look to K & M valves for proved sensitivity and endurance. K & M is geared to handle the smallest or largest problem in control valves, however exacting the requirements. Our engineers invite your inquiries.

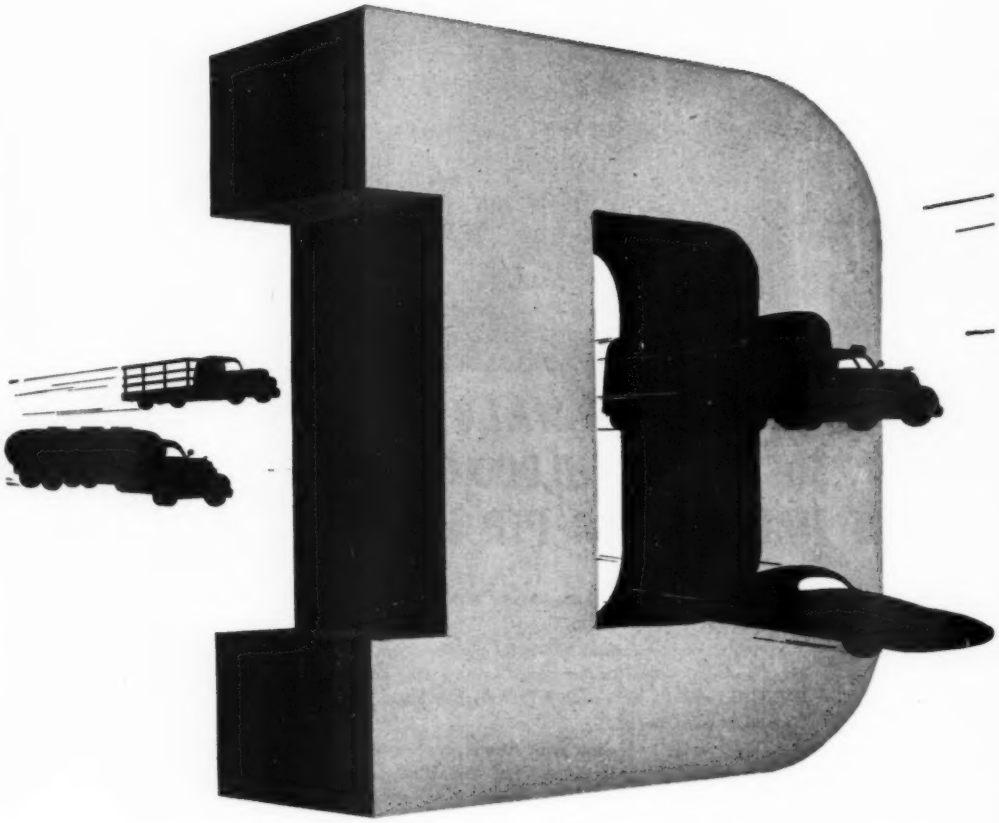


K&M

KIELEY & MUELLER, INC.

Valve Makers Since 1879

2033 - 43rd STREET NORTH BERGEN, N. J.



DAVISON DEPENDABLE CATALYSTS BUILD BETTER MOTOR FUEL

The operating efficiency of synthetic fluid-type cracking catalysts is important. This operating efficiency can be assured by uniformity of physical characteristics and chemical purity. Davison's production of microspheroidal (M-S*) is tops in uniformity . . . providing all users with a highly efficient synthetic fluid-type cracking catalyst. Your requirements can also be supplied in ground (DA-1*) form. Write for further descriptive information. Experienced Davison Field Service Engineers backed up with complete laboratory testing facilities are part of Davison's service.

*T.M.T.D.C.C.

Progress Through Chemistry

THE DAVISON CHEMICAL CORPORATION

Baltimore 3, Maryland

PRODUCERS OF: CATALYSTS, INORGANIC ACIDS, SUPERPHOSPHATES, PHOSPHATE ROCK, SILICA GELS, SILICOFLUORIDES AND FERTILIZERS

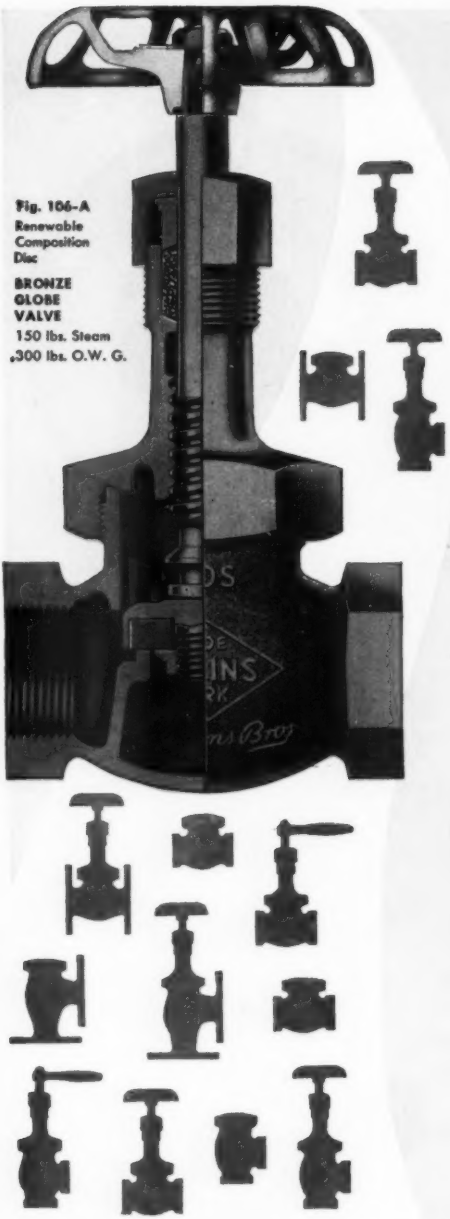


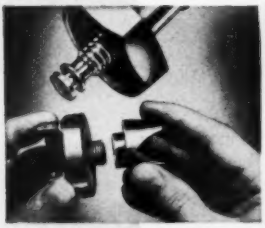
Fig. 106-A
Renewable
Composition
Disc

**BRONZE
GLOBE
VALVE**
150 lbs. Steam
300 lbs. O.W. G.

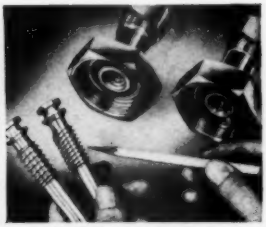
All these Valves . . from One!

Valve combinations for 90% of industrial piping assembled with 4 bodies and a handful of parts.

JENKINS FIG. 106-A "FAMILY"
Start with the standard Fig. 106-A. Trimming is interchangeable in Globe or Angle body, screwed or flanged.

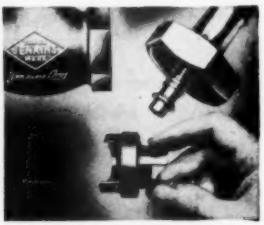


For Close Control — In throttling service, the nut which holds the disc in the disc holder is removed and replaced with Throttling Nut, Fig. 344.



For Quick Opening and Closing — Merely substitute the bonnet and spindle from Fig. 941, in which threads are pitched more sharply.

For Lift Check Service — Globe or Angle Bodies can be fitted with interchangeable Cap, Disc Holder, and Guide Disc Nut from Fig. 117A. Addition of spring from Fig. 655A provides spring loaded service.



For Stop & Check Service — Use the 106A trim, but substitute this spindle from Fig. 630A and replace the regular disc nut with the check valve guide disc nut.

Look over these pictures and see how easy it is to make up just the valve type you need, simply by interchanging parts. Think of the saving this means in maintenance expense . . . in reduced inventory of spare valves in your stockroom.

That's a big reason why the Fig. 106-A series takes top honors in any poll for valve preference. And Jenkins time-proved design, makes them the longest-lasting, lowest-upkeep valves that money can buy.

For example, see the heavy construction of the one-piece, screw-over bonnet. You can remove and replace it over and over again without distortion. See the extra size packing box,—and the perfectly machined threads on the heavy manganese bronze spindle, with more threads in contact with the bonnet, open or closed.

Remember, Jenkins Bros. is the originator of the renewable composition disc valve,—the *only* manufacturer of both valves *and* discs. For drop-tight, trouble-free performance, get acquainted with the Fig. 106-A "family". Despite their extra value, *you pay no more* for Jenkins Valves. Jenkins Bros., 100 Park Ave., New York 17, N. Y. Jenkins Bros., Ltd., Montreal. Sold through leading Industrial Distributors.

JENKINS
LOOK FOR THE DIAMOND MARK
VALVES
SINCE 1864

Blooming Mill *Scratchboard Drawing for Pittsburgh Steel Company by T. W. Hunter*

Progress in Steel

New Blooming Mill Now Operating

More steel for defense—more steel for vital civilian needs is now being produced at Pittsburgh Steel Company as a part of its Program of Progress. With the completion of the giant new high-lift blooming-slabbing mill, shown above in operation, another important phase in this extensive plan has become a reality.

The new mill is rolling heavier ingots and rolling them faster than the old equipment to supply more high-quality steel to the Pittsburgh seamless tube mills, the rod and wire mills. Later, slabs for the new 66-inch hot strip-sheet mill, now under construction, will also be rolled on this multi-million dollar mill.

Despite its impressive size and importance, the new blooming mill is but one part of Pittsburgh Steel's Program of Progress. Other steps, such as the acquisition of the Thomas Strip Division at Warren, Ohio, have also been completed. In the steel works, more raw material is being provided—blast furnace capacity increased—open hearth furnaces enlarged—all designed to increase total ingot production by fifty percent.

The need for more steel grows daily as defense production is increased. The steel industry has accepted the responsibility of supplying greater quantities of this critical material and is expanding its capacity by millions of tons. The Program of Progress at Pittsburgh Steel is an important part of this unified effort which is designed to protect us from aggression and still adequately serve our daily needs.

Pittsburgh Steel Company

Pittsburgh, Pennsylvania

FOR LOW-COST MAINTENANCE with the greatest of ease!

See how Darling cast steel gate valves save you time and money!

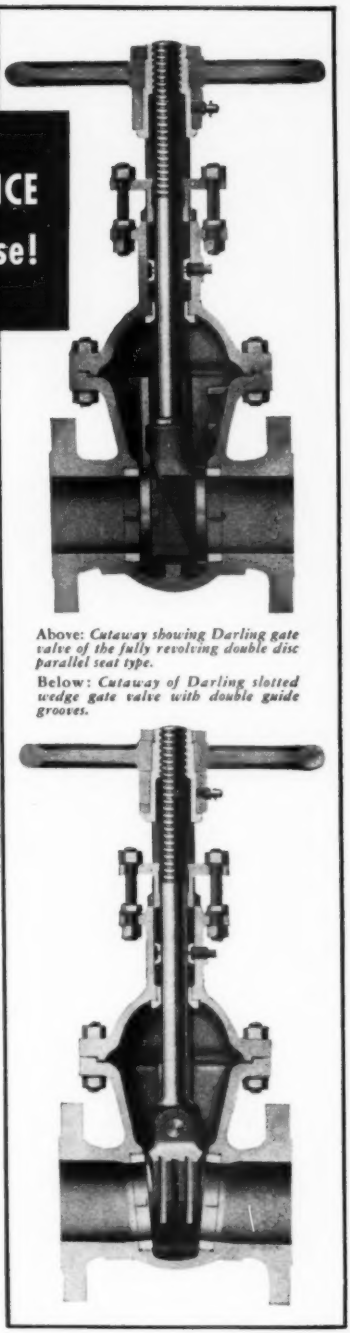
YOU know how important low-cost, *easy* maintenance can be. It's one of many Darling Valve features worth shouting about.

For example, all *Darling* parts are precision-made to jigs and templates. Replacement parts slip in quickly and easily.

What's more, Darling valves are designed so that seat rings and all working parts are easily removed and replaced without taking the valve bodies from the line.

These maintenance and repair advantages, plus many other time-and-money-saving features, apply to Darling gate valves of both popular types shown at right. It adds up to low-cost performance at its over-all *best!* Ask for the Darling Cast Steel Valve Bulletin. Get *all* the facts so you can judge for yourself!

FOR PLUS VALUES, JOB-PROVED AGAIN AND AGAIN



Above: *Cutaway showing Darling gate valve of the fully revolving double disc parallel seat type.*

Below: *Cutaway of Darling slotted wedge gate valve with double guide grooves.*

FOR EVERY NEED. *Darling gate valves are made in a wide range of sizes, types and constructions for all kinds of normal and unusual service . . . and for pressures up to 1500 pounds.*

DARLING VALVE & MANUFACTURING CO.

Williamsport 1, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ont.

Only coupling that absorbs vertical thrust loads—

MORSE MORFLEX RADIAL

The motor above is one of four that drive giant cooling fans in a Lion Oil Company natural-gasoline dry cooler. Joining reducer output shaft to vertical overhead fan shaft, the Morse Morflex *Radial* Coupling absorbs vertical thrust—and compensates for misalignment.

Tough Neoprene biscuits (a Morse exclusive) in Morse Morflex Radial Coupling absorb thrust, shock, vibration. They compensate for misalignment, reduce bearing load, prevent metal-to-metal contact, eliminate lubrication and maintenance. Because of the Neoprene biscuits, abrasive dirt, chemicals and water have no harmful effect on Morflex Radial Couplings.

Morse Morflex

Morse Morflex Coupling shown between motor and reducer is primarily designed for use on horizontal shafts. It, too, compensates for misalignment, dampens torsional load fluctuations, absorbs harmful vibration. The Morse Morflex Coupling cushions shock, needs no lubrication, no maintenance.

Check into these versatile, unbeatable Morse flexible couplings for your applications. Let us send you information on the Morflex and Morflex Radial.

M = PT Morse *means* Power Transmission

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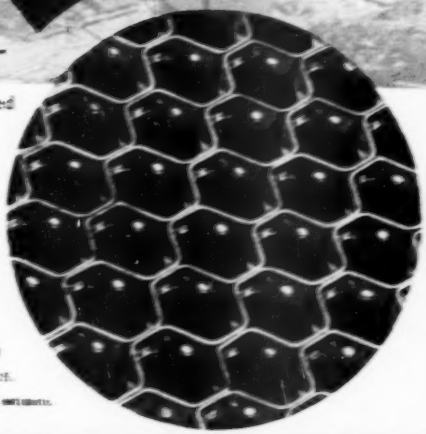
4 Billion Dollars Increased Production Earnings WITH THE AID OF KLEMP HEXTEEL

Among more than 40 Oil Companies using Klemp HEXTEEL FLOORSTEEL and Grating are:

Globe Oil & Ref., Wichita, Kansas
Phillips Oil Co., Bartlesville, Okla.
Standard Oil of Ind. Humble Oil Co., Houston, Texas
Standard Oil of N. J. Universal Oil Co., Chicago
Gulf Oil Corp., Pittsburgh, Pa.
Sinclair Oil Co., N. Y.
Sinclair Oil Co., Warren Point, Pa.
Magnolia Petroleum Co., Dallas, San Antonio, Texas
Utah Oil & Refinery Co., Salt Lake City, Utah
Texas Company of Houston, New York, Tulsa, Chicago
Shell Oil Co., of N. Y., Wilmington, Houston
Cities Service Oil Co., of East Chicago and Indiana
Pure Oil Co., Chicago
Texas Pacific Co., El Dorado, Ark.
Imperial Oil Co., Toronto, Ontario, Canada
Tri-Con Oil Corp., N. Y.
Elk Refining Co. Charleston, W. Va.
Republic Oil Refining Co., Texas City, Texas
Atlantic Refining Co., Philadelphia, Pa.
Sun Oil Co., Philadelphia and Toledo, Ohio

Fluid and cat-cracker gasoline linings, reinforced by Hexteel, stand the higher temperatures and pressures . . . allow production of more gasoline from the same amount of crude. This extra output, from the 2 million barrels of crude passing thru Hexteel-lined distillation units daily, is boosting the nation's refinery income by 4 *million* dollars!

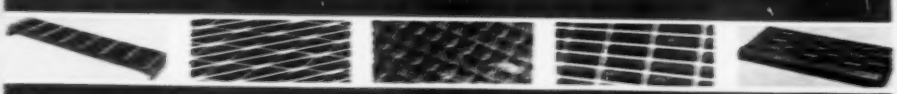
Hexteel is welded directly to wall or attached to studs, and cement or lumnite is gunited into mesh. Hexteel comes in 3/8", 1", or 1 1/4" by 12 or 14 gauge steel—cut to your specifications. Also furnished in stainless steel. [illegible]



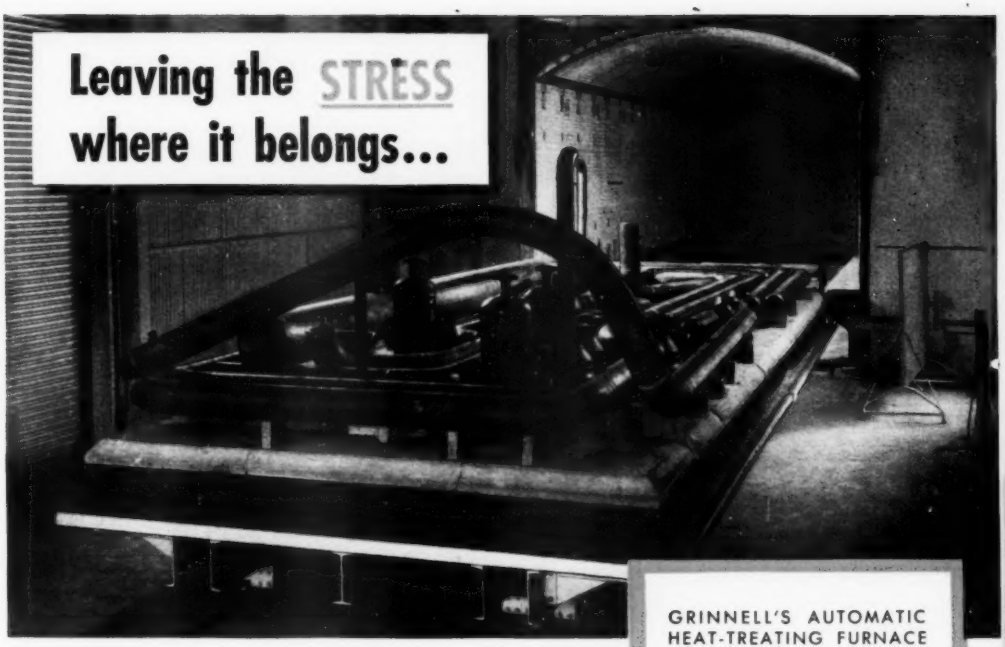
KLEMP HEXTEEL®

Factories in Chicago and Houston. Sales Representatives in 1200 U. S. cities and 300 foreign countries.

SEE YOUR CLASSIFIED TELEPHONE DIRECTORY UNDER "GRATINGS"



Leaving the STRESS where it belongs...



Stress relieving prefabricated piping with highly developed equipment and special techniques is one reason why exacting specifications are met with

GRINNELL PREFABRICATED PIPING

Grinnell received an order recently for stress relieving prefabricated piping to these specifications:—

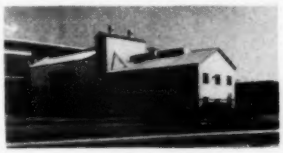
> "All fabricated pieces shall be normalized and drawn by heating to a uniform temperature of 1700°F (plus or minus 25°F). This temperature shall be maintained on a basis of one-half hour for each quarter inch of wall thickness of the heaviest pipe in the furnace charge followed by air cooling not less than 600°F. All pieces shall then be reheated to 1425°F and held at temperatures as above. In no case shall the time be less than 2 hours . . . Cool at a controlled rate not to exceed 200°F per hour until 600°F is reached . . ."

Grinnell, of course, met these specifications precisely. In fact, fabricating industrial piping today demands the *maximum* in versatility and precision.

Modern power plants, for example, need piping of heavy cross-sectional area and definite alloy composition to provide high temperature stability, resistance to creep and graphitization. Chemical and oil refining processes, on the other hand, must have piping of high chrome alloy to impart strength at high temperatures, resist corrosion, withstand impacts at low temperatures. Heat-treating often is the only answer — either to restore properties affected during fabrication, or improve original properties.

GRINNELL'S AUTOMATIC HEAT-TREATING FURNACE

performs with positive efficiency. This versatile stress-relieving unit, measuring 12 by 12 by 40 feet and using gas or oil or both as fuel, was designed to give full program control for the entire range of working temperatures. It provides instrument control of rate of rise in temperature of the charge, length of time for holding at the predetermined temperature level, and cooling rate. Two recording controllers are provided for the furnace and a separate 6-point recorder registers the temperatures of the charge simultaneously during the treating cycle.



Exterior View of Building

In heat-treating, as in everything else for piping, Grinnell has the experience and the costly equipment to fully protect large piping expenditures. That is why it will always pay you to call on Grinnell for *all* of your piping needs.

GRINNELL

WHENEVER PIPING IS INVOLVED

Grinnell Company Inc., Providence, Rhode Island • Sales Offices and Warehouses in Principal Cities

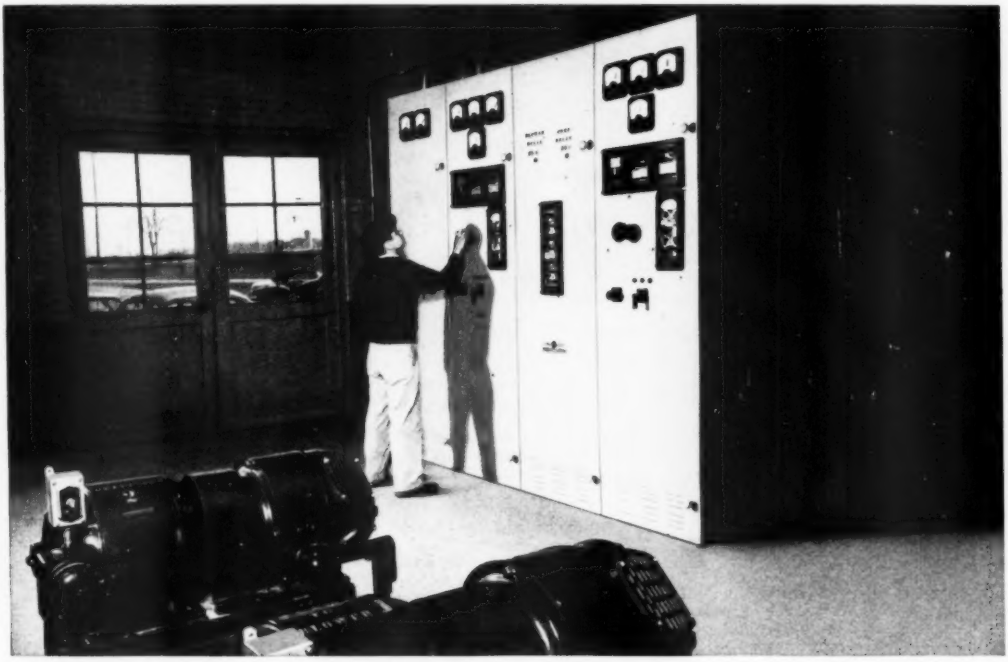
pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

A PHOTO-REPORT ON MODERN

G-E equipment helps cat cracker operate 'round the clock!

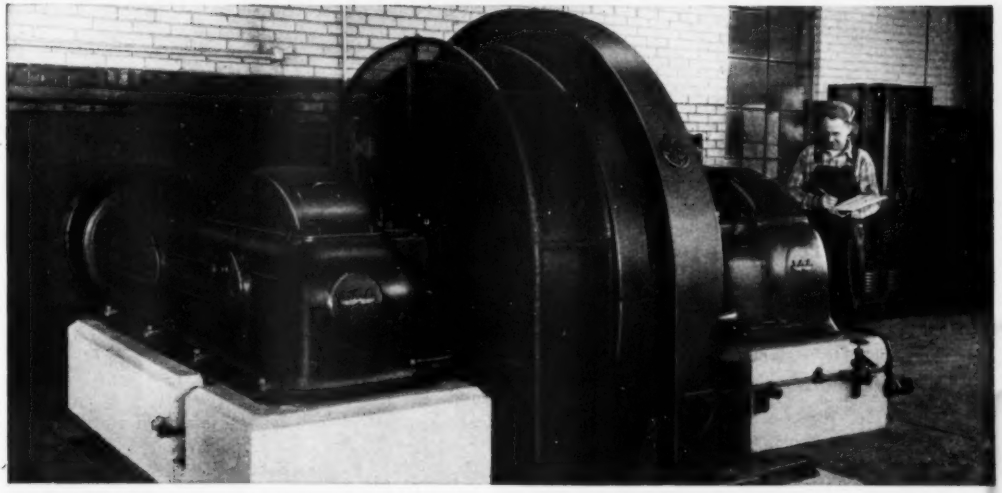
Hazardous and corrosive atmospheres present no problem for plant's G-E explosion-proof motors

As part of a new construction program, Rock Island Refining Corp. recently added a fluid catalytic cracking unit to its refinery near Indianapolis, Ind. Here 12,000 barrels of crude per day are refined into kerosene, naphtha, gasoline and other products. Here G-E equipment—selected and applied for reliable operation in hazardous and corrosive areas—helps keep production going three shifts per day, 24 hours every day! And here, too, is more proof that G.E. can handle any refinery electrification problem—including yours. See your G-E representative—early in your planning. *General Electric Company, Schenectady 5, N. Y.*



Installed in a non-hazardous area at Rock Island, this G-E metal-clad switchgear—a compact, space-saving unit—controls incoming 4160-volt a-c power going to two synchronous motors in the refinery. The motor generator sets, in foreground, supply field current for these motors.

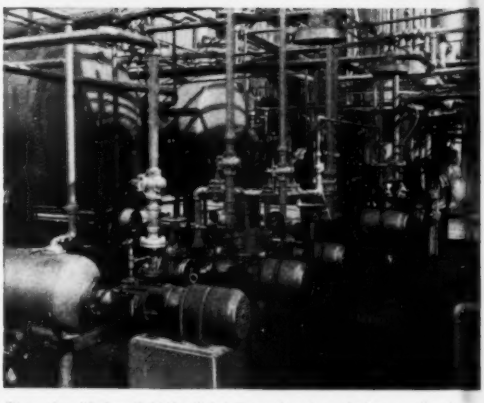
GENERAL ELECTRIC



Proved dependability and minimum maintenance make G-E synchronous motors a top refinery choice. This G-E 400-hp 4160-volt synchronous motor drives two gas compressors in the fluid catalytic cracker.

Corrosion and weathering doesn't harm G-E totally-enclosed explosion-proof motors. At Rock Island, the two G-E 40-hp motors of this type in foreground drive crude charge pumps, while the two G-E 15-hp vertical motors of the same type in background drive pumps charging partially refined oil directly to the cracking unit.

New G-E Motor Selection and Application Course can help train your refinery employees, increase their efficiency. A G-E "More Power to America" program, it shows how motors work, types now in use, how to select and apply them for specific jobs. Write now for Bulletin GEA-4938-16 describing the course in detail.



Five of a kind—all G-E, all totally-enclosed explosion-proof—these motors vary in rating from 2 to 20 hp. They are used to "charge" gasoline and burning oils to Rock Island's treating plant, where objectionable odors and sulphur compounds are removed or transformed.

Co-ordinated

ELECTRIC EQUIPMENT

for fluid catalytic cracking

WELDING FITTINGS ON YOUR MIND

It will pay you to think of Midwest whenever you think of welding fittings. For example: the variety of elbows offered only by Midwest provides greater latitude in piping design and permits improvements and economies not otherwise possible.

Same radius as ASA but tangent equal to 25% of nominal pipe size on each end. Saves pipe, layout and welding time. Costs no more than ASA. Sizes to 24".

Dimensions conform to applicable size range of American Standard for Butt-Welding Fittings, ASA B16.9. Tolerances much less than allowable. Sizes to 26".

Recommended where space limitations do not permit use of "Long Tangent" or ASA Elbows. Sizes to 30".

Takes the place of a straight size elbow and a reducer. Eliminates one weld, reduces pressure drop, easier to insulate. Sizes to 12", reductions to half size.

4580

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PIPING & SUPPLY CO., Inc.

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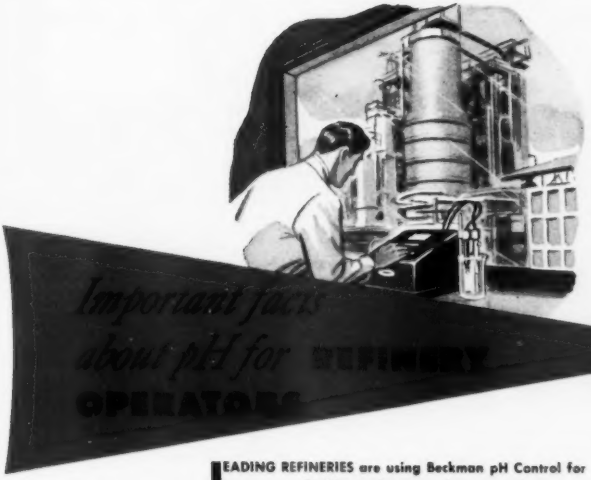


Important facts about pH for REFINERY OPERATORS

LEADING REFINERIES are using Beckman pH Control for many profitable applications that save time, save money, minimize maintenance and increase plant efficiencies. Whether yours is a small or a large refinery, be sure to investigate the savings to be made by such typical applications as these . . .

- **NEUTRALIZING CRUDE STOCK ACIDITIES** to prevent damage and corrosion to costly plant equipment.
- **MAINTAINING CONSTANT COOLING WATER CHECK** for immediate detection of hidden leaks in lines and equipment.
- **TREATING PROCESS AND BOILER FEED WATER** to assure soft, neutral water, greater freedom from liming and boiler maintenance, and substantial savings in chemicals.
- **NEUTRALIZING ACIDS IN STILLS** to assure a uniform, acid-free product.
- **ACCURATE CONTROL OF WASTE DISPOSAL** with better neutralization of acid and caustic effluents . . . at substantially lower chemical costs.

. . . and many other savings in modern refinery and production operations.

Write for full details.

TO MAKE CERTAIN you get the latest, most convenient and most accurate pH equipment, be sure to specify "BECKMAN" . . .

✱ Beckman pH equipment is completely electrometric, eliminating the mess and inaccuracies of colorimetric methods. Simply press a button and the exact pH of any process is instantly shown on a large easily-read dial. *It is the simplest of all pH methods!*

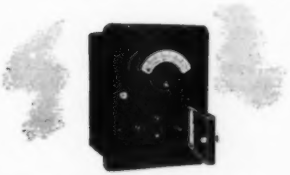
✱ With Beckman equipment no time-wasting or troublesome sampling devices are needed. Beckman pH electrodes may be installed directly in vats, tanks, channels or flow lines—and exact pH values read instantly—and *continuously*, if desired—on the process fluids themselves.

✱ The accuracy of Beckman pH readings is completely unaffected by human errors in color judgment, by turbidity, oxidizing or reducing agents, by suspended materials, colored process solutions or other variables that affect outmoded colorimetric methods. *Beckman pH readings are universally accurate and dependable!*

✱ Unique rugged-type Beckman Electrodes, especially designed for direct immersion in abrasive or suspension-laden fluids, reduce maintenance to an absolute minimum. *Beckman is the most trouble-free of all pH equipment!*

The above are only a few of many Beckman advantages. Write for the complete story.

There's a Beckman pH Instrument to meet your needs!



COMPLETELY AUTOMATIC! The Beckman Model R instrument operates directly from standard 110 v. A.C. lines to provide completely automatic pH indication. Also provides for completely automatic pH recording and automatic process control. Can be installed to give accurate pH readings from various stations in plant through one instrument. *This is the pH unit being installed by today's most modern plants, large and small.*

PORTABLE A.C. OPERATION! The Beckman Model H instrument can be quickly moved from one part of the plant to another and plugs directly into standard 110 v A.C. current. Compact, convenient and extremely simple to operate, the Model H gives *instant* pH readings on an easily-read dial. Widely used both for manual pH control of small plants and as an auxiliary instrument on completely automatic pH installations.

COMPLETELY SELF-CONTAINED! The Beckman Model N is the ideal instrument where complete portability is desired. Operating from its own self-contained, long-life power supply, the Model N can be used *anywhere*—in plant, field or laboratory—without dependence on A. C. power circuits. Features maximum compactness, simplicity and operating convenience, coupled with extreme ruggedness. Available in two types . . . the N-1 with separate Buffer, KCl solution and beaker . . . the N-2 with integral case for Buffer, KCl solution, beaker, thermometer, etc.

BRING YOUR pH PROBLEM TO US. Our trained engineers will gladly study your problem and recommend the equipment best suited to your particular requirements. No obligation, of course.

Write for literature on Beckman pH Equipment!

BECKMAN INSTRUMENTS INC

SOUTH PASADENA 24, CALIFORNIA

Factory Service Branches: Chicago • New York • Los Angeles

Beckman Instruments include: pH Meters and Electrodes—Spectrophotometers—Radioactivity Meters—Special Instruments

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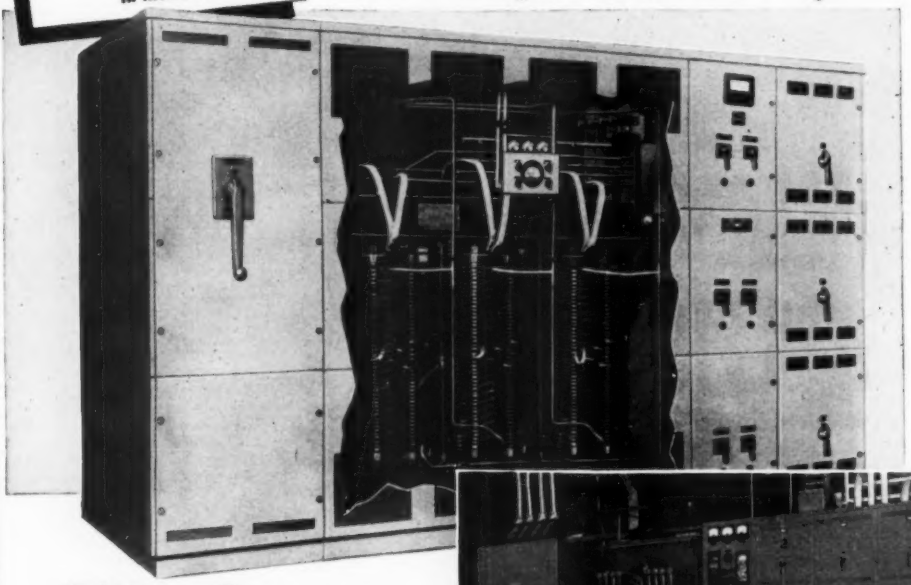
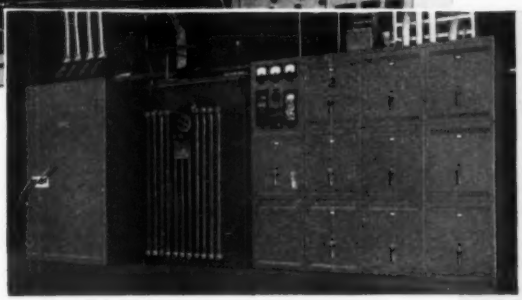
TRANSFORMERS
...the choice of leaders in industry

always specify...





Oil filled and non-inflammable liquid filled (Noflamol) transformers are available with various types of entrances and controls for high-voltage circuits, and with throats on the secondary side, in ratings up to 2000 kva.

Wagner
UNIT SUBSTATION TRANSFORMERS
for dependable load-center power distribution

The importance of the transformers in your plant power distribution system cannot be over-emphasized. If a switch or a circuit breaker fails, only a part of the system is affected—but if the *transformer* fails, the entire system is dead. Wagner Unit Substation Transformers assure a continuous, dependable flow of power.

Wagner three-phase dry-type load-center transformers are built in ratings through 2000 kva in the 15-kv class and below. Transformer and incoming line section are housed in compact factory-matched enclosures, designed for direct connection to matching secondary switchgear to form a closely coupled unit substation that is streamlined in appearance and readily accessible. Complete enclosure of all equipment assures safety against contact with live parts.

Wagner Dry-Type Unit Substation Transformers are for indoor installation in dry, clean, well ventilated locations. Because of their relatively light weight they can be used in multi-story buildings. Wagner Liquid-Filled Unit Substation Transformers are available for indoor or outdoor installation.

Bulletins TU-56 and TU-13 give full information on Wagner Dry-Type and Liquid-Filled Substation Transformers. Write for your copies.

WAGNER ELECTRIC CORPORATION
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ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS — AIR AND HYDRAULIC

BRANCHES IN 32 PRINCIPAL CITIES

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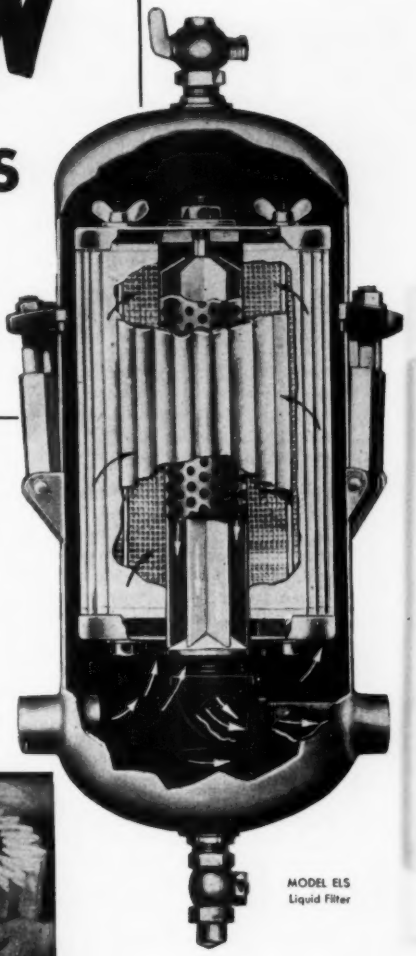
STAYNEW

LIQUID FILTERS

Solve Your Filtration Problems!



MODEL ELS
Liquid Filter

Bring your liquid filtration problems to Dollinger engineers. Their specialized experience is available in recommending the most efficient and economical equipment for filtering liquids in a wide range of viscosities, temperatures, acidities, alkalinities, pressures and capacities.

Staynew exclusive design, permits use of *any medium in sheet form that can be crimped.* Metal, plastic, fabric, ceramic and metallic mesh media can be used for super-fine filtration.

Write us today outlining your specific liquid filtration problem. From our 30 years experience in liquid filtration, we have built up a vast file of helpful information. Any part of this information is yours for the asking—no obligation.

Staynew Radial Fin Construction provides the largest possible filtering area for available space. Slip-On Insert—exclusive in Staynew Filters—permits simple, inexpensive cleaning or replacement of media.

Representatives in Principal Cities

DOLLINGER MFG. PROTECTOMOTOR STAYNEW FILTERS

DOLLINGER

CORPORATION

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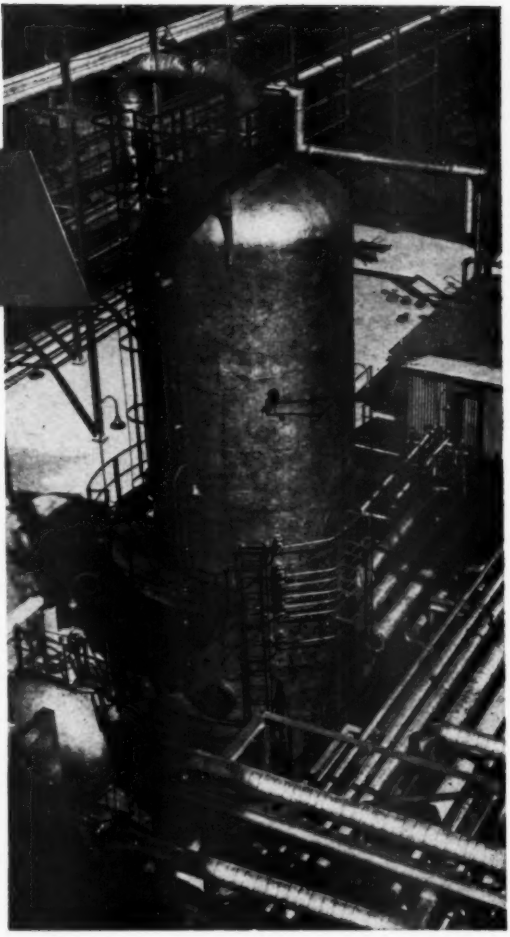
ALL TYPES OF FILTERS FOR EVERY INDUSTRIAL NEED

5 reasons why TRETOLITE DESALTING is a good investment



1 Tretolite Desalting is a good investment because it need not be a *large* investment. The Tretolite process utilizes conventional refinery equipment, often permitting a plant to be put in operation by using only existing refinery equipment.

2 Tretolite Desalting achieves effective desalting with minimum treating procedures. The Tretolite desalting chemicals, at low ratio, are added by means of a conventional chemical pump to the charging crude. The salt-bearing crude and fresh water are heated, mixed, emulsified, and passed into the settling drum. The salt-bearing water is drawn off; the desalted crude passes on into the refinery charge.

3 Tretolite Desalting not only removes salt with removal efficiencies of around 90%, it also separates insoluble solids such as sand, shale, drilling mud, etc., thereby preventing their accumulation in refinery equipment upstream.

4 Tretolite Desalting is backed by a Desalting Service Staff. Tretolite Desalting Engineers are available to assist any refiner, from a preliminary salt survey through the plant construction, start-up and continuing operations. Mobile test equipment can be moved right into your refinery for an accurate estimate of expected desalting performance.

5 Tretolite Desalting is adaptable to any size refinery. Plants now in operation are efficiently handling streams from as small as 2,000 barrels per day to as high as 50,000 barrels per day. Over a million barrels of crude per day are being desalted by Tretolite.

When you invest in desalting, be sure you get the most desalting for your desalting dollar. Your inquiries are welcomed, and will receive prompt attention.

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DESALTING • CORROSION INHIBITING
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TRETOLITE COMPANY

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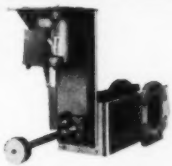
R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •

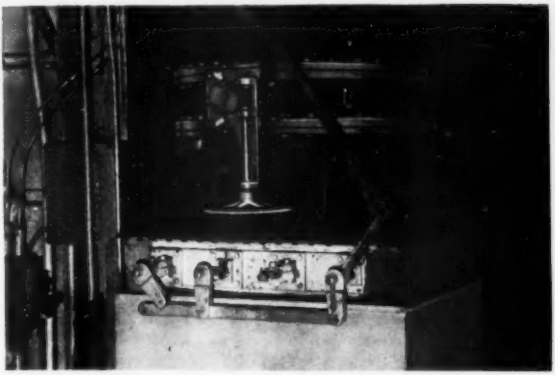
WATER SERVICE—No. 825—36-inch 125-pound cast iron valve equipped with 18—8 shafts, bronze bushings and rubber seat for 85-pound drip tight shut-off.

EMERGENCY OIL SERVICE—No. 628—solenoid trip valve. Should the solenoid function, the latch is tripped which causes the counter-weight to open or close the valve by gravity. Available in any metal or alloy and in various sizes for emergency shut-off or vent for air, gas, steam, oil, and water.



700° F. EXHAUST GAS SERVICE—No. 826—6-inch 125-pound R-S "H" metal valve used on small turbine generator. Equipped with 18—8 shafts, hastelloy bushings, finned lubricated stuffing box and solenoid trip mechanism.

STEAM SERVICE—No. 677—1500-pound welding end steel valve for superheated steam—A. S. M. E. Standards.



SEMI-SOLID SERVICE including abrasive and corrosive materials.

R-S VALVES
Control and Shut Off Practically Any Material

The beveled vane seats firmly at a 12½° angle and is closed from a fully open position through 77½° of arc by either manual or automatic operation. A metal-to-metal seat gives satisfactory commercial shut-off. When required, Monel or stainless steel can be welded to the vane periphery and a babbitted seat used in the valve body. Drip tight or bubble tight closure can be obtained with a rubber seat.

Power controlled prime movers delivering the necessary foot pounds of torque open or close these self-cleaning valves at any desired speed from one second to eight minutes according to requirements. Pressures range from 2 to 2500 psig and temperatures from minus 300° F. to plus 2000° F.

Such simplicity of design, adaptability and operating ease are the reasons why R-S Valves can be installed to control and shut off the volume and pressure of any material that flows or is forced through a pipe.

Obtain full details from your R-S representative.

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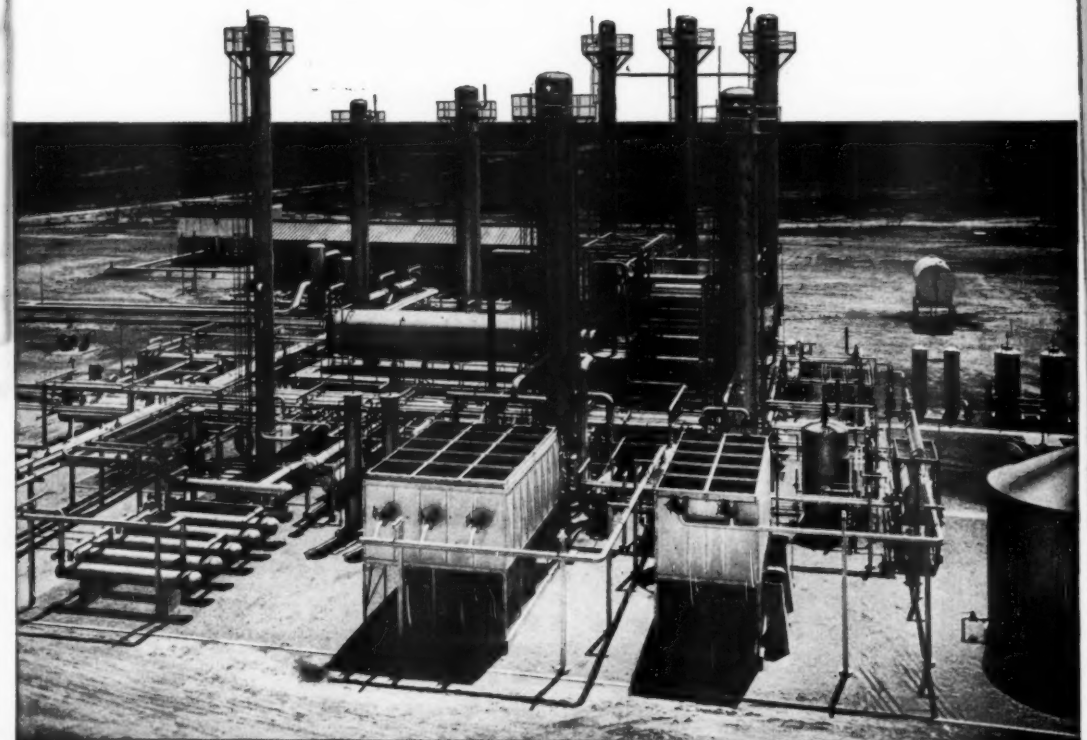
G-R



GRISCOM - RUSSELL PIONEERS IN HEAT TRANSFER APPARATUS

Heat Exchangers

all 3 types are in this installation

Here's a striking instance of the broad range of G-R Heat Transfer Apparatus.

In this natural gasoline plant, the G-R equipment consists of *water-cooled* compressor intercoolers, still condensers and product coolers . . . *oil-cooled* lean oil exchangers . . . and *air-cooled* exhaust steam condenser and still reflux condensers.

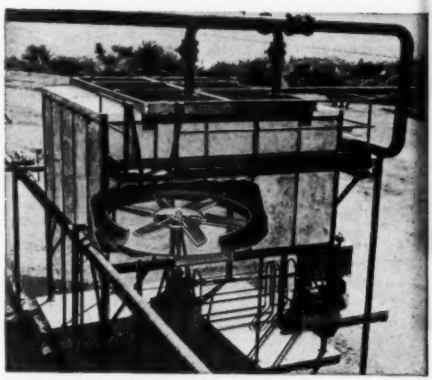
In addition, the plant also uses G-R Reboilers and a G-R Type H Evaporator.

What does this mean to *you?* It indicates, first, that whatever may be your heat transfer processes, there is an exactly suitable G-R design. It indicates, secondly, that whatever may be your plant conditions, G-R can furnish the correct type of equipment to meet those conditions. And finally, it indicates that this plant, like many hundreds of others throughout the oil and gas industry, has preferred and standardized on G-R Apparatus for all heat transfer requirements.

Whenever *you* need heat transfer apparatus, consult the G-R engineers to be sure of best results.

THE GRISCOM-RUSSELL CO.
MASSILLON, OHIO

G-R TWIN G-FIN SECTION
The most widely used heat transfer apparatus on the market. Adaptable to a broad range of heating, cooling, condensing and heat transfer services.



FIN-FAN EXCHANGER
Jointly developed by The Griscom-Russell Co. and Fluor Corporation Ltd., to provide an air-cooled unit suitable for cooling and condensing services wherever the water supply is insufficient or of poor quality.

GRISCOM-RUSSELL

GR-235

THIS HAT FITS YOU

• Fire protection is an important part of your job. Don't wait until fire proves it by closing the doors of your business . . . let a Kidde expert help you start planning fire protection *now*.

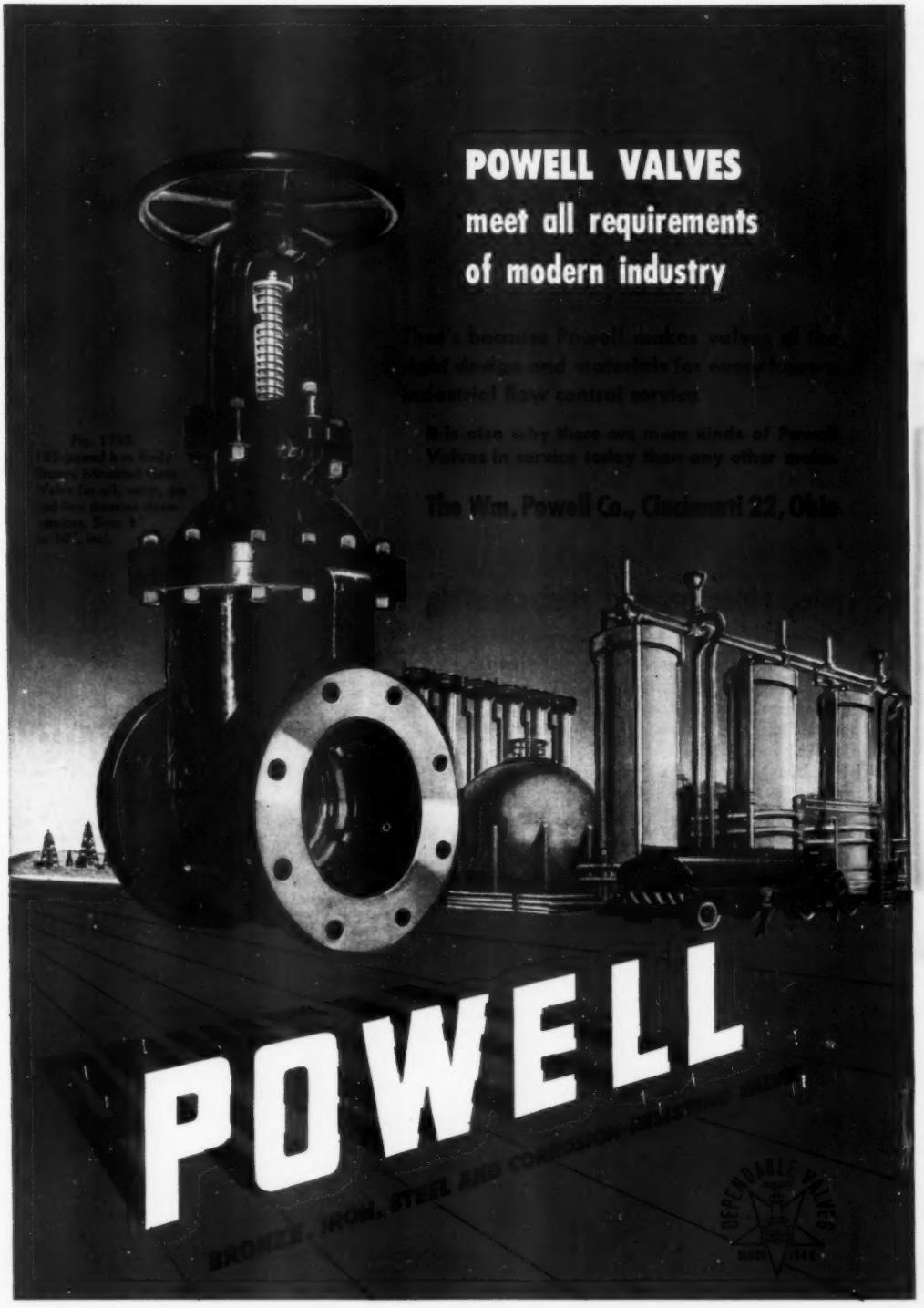
A Kidde Automatic Fire Extinguishing System may solve all your fire protection worries. Such a system is on the alert against fire 24 hours a day . . . every day. The heat from a fire hits a sensitive Kidde detector . . . causes the release of fire-smothering carbon dioxide. In seconds the fire is out.

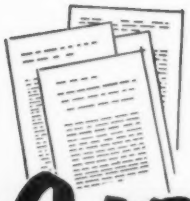
Remember, too, that a Kidde system causes no water damage to documents, furs, electrical equipment or valuables. Write us today for further information.

Kidde

Walter Kidde & Company, Inc.
354 Main Street, Belleville 9, N. J.

Walter Kidde & Company of Canada, Ltd., Montreal, P. Q.


POWELL VALVES
meet all requirements
of modern industry
POWELL
DEPENDABLE VALVES

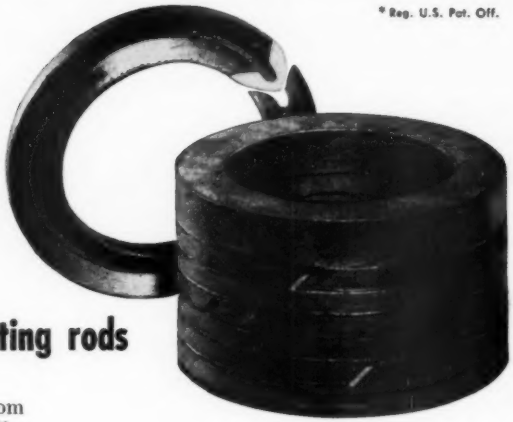


Service Reports Show that

GARLOCK CHEVRON*

* Reg. U.S. Pat. Off.

SEALS BETTER, LASTS LONGER



than ordinary V-type packings on rams, plungers and reciprocating rods

GARLOCK CHEVRON Packing is entirely different from an ordinary V-type packing. Its distinctive hinge-like construction provides greater flexibility without loss of strength and results in a quicker, positive automatic sealing action.

With increasing pressures Chevron rings tighten and prevent leakage; with decreasing pressures the packing eases off and permits operation with a minimum of friction.

Service reports, such as those at the right, prove that Chevron seals better, needs less maintenance, and lasts longer.

For general applications specify 430 CHEVRON for cold and warm water service; 431 CHEVRON for cold and warm oil; 530 CHEVRON for steam, air or gas; 531 CHEVRON for hot oil. For special applications GARLOCK CHEVRON is made of "Teflon" and other special materials.

Typical CHEVRON Service Reports:

- Oil hydraulic presses packed with ordinary V-type packing. Due to oil seepage down ram special hoods had to be installed to protect operators. Installed all-synthetic rubber type Chevron alternated with Garlock Bitan V leathers. Result-rams are perfectly dry and protective hoods have been removed.
- Boiler feed pump in state institution. Operates average of 6 hours per day—365 days per year pumping water at 212-220 deg. F., 170 psi. discharge, 15 ft. head positive suction. Packed with Garlock 430 Chevron in 1942. Packing still operating efficiently.
- Reciprocating pumps in pipe line pumping stations. Pressures up to 700 psi. Stuffing boxes bushed to shallower depth as only four Chevron packing rings required to handle work performed previously by a much greater number of ordinary packing rings. Maintenance men very pleased with long life of Chevron packing and particularly lack of need for gland adjustment for changes of gravity in the crude oil being pumped.

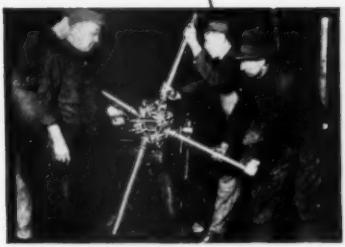
THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

Tulsa, Okla. Houston, Tex.
Los Angeles, Calif.

GARLOCK PACKINGS, GASKETS, OIL SEALS, MECHANICAL SEALS

TOOL UP FOR PROGRESS with TOLEDO

...Leader in Pipe Tools for 50 Years!

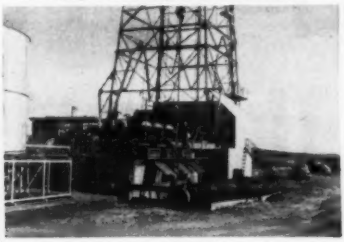


Threading 3" pipe was a slow, tedious job with this old-time device (not a Toledo).

Today, 4" pipe can be cut off, reamed, threaded in close to a minute using Toledo No. 1-2-4 machine.

Typical old-time oil scene with wooden derricks and cable tool drilling equipment in background.

Today, drilling has gone 20,521 ft. deep—the world mark set by this giant rig in Wyoming. Toledos speed threading for all oil industry.

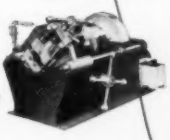


Fifty years ago . . . in the days of Henry Ford's first car and the Wright Brothers' flight . . . a revolutionary new principle in pipe threading was discovered by W. W. Vosper, inventor of Toledo Pipe Tools and now Chairman of the Board.

This was destined to ease the work and save time of mechanics for years to come. Instead of solid dies, segments were used with only enough teeth on their cutting edge to form a thread—thus reducing friction. Also, as the thread was cut the dies receded—thereby further relieving friction.

This was the beginning of Toledo Pipe Tools in 1902 . . . the Leader in its field since the very start. Today—better mechanics from coast to coast prefer TOLEDO hand tools and power pipe machines . . . to *speed the work* and *reduce costs!* Write for new catalog. The Toledo Pipe Threading Machine Co., Toledo, Ohio. New York Office: 165 Broadway, Room 1310.

Toledo Simpact, self-contained, 1" to 2" threader.



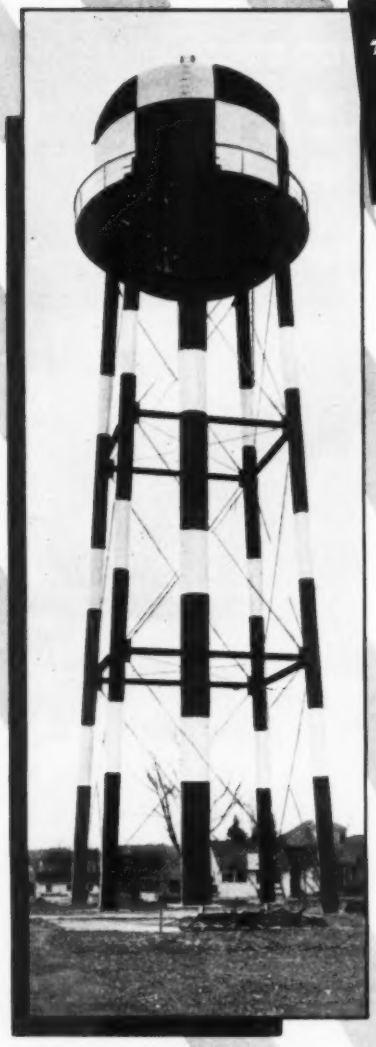
Toledo No. 999 2" Power Pipe Machine.

RELY ON THE LEADER

TOLEDO PIPE TOOLS...

POWER PIPE MACHINES...POWER DRIVES

Here's a Steel Plate Fabricator Who Talks The OIL MAN'S LANGUAGE



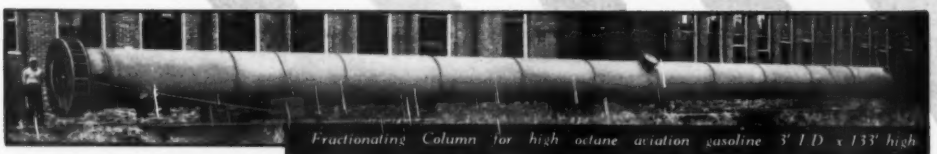
For a long time . . . and on a wide range of steel plate construction and erection jobs . . . Posey Iron has been "talking it over" with oil men. Practical, work-a-day experience with refinery and oil field installations has acquainted Posey Iron engineers with "the facts of life" in the oil business.

You'll find we understand peak loads . . . pressures . . . reserve capacities . . . fire protection requirements . . . alloys . . . welding practice . . . and specialized construction *as they apply to the oil field.* Every Posey Iron tank is fabricated with an ample safety factor . . . and to meet standard codes.

The Posey Iron Work's plant (16½ acres under roof) has complete facilities for machining . . . x-raying . . . pickling and painting. A consultation with one of our engineers may result in economies in your steel plate fabrication work.

View of 200,000 gallon tank with ellipsoidal bottom designed . . . fabricated . . . and erected by the Posey Iron Works

Alloy Steel Refinery Pipe awaiting shipment from Posey Iron's North Plant



Fractionating Column for high octane aviation gasoline 3' I.D. x 133' high

POSEY IRON WORKS, INC.

Steel Plate Division

LANCASTER, PENNA.

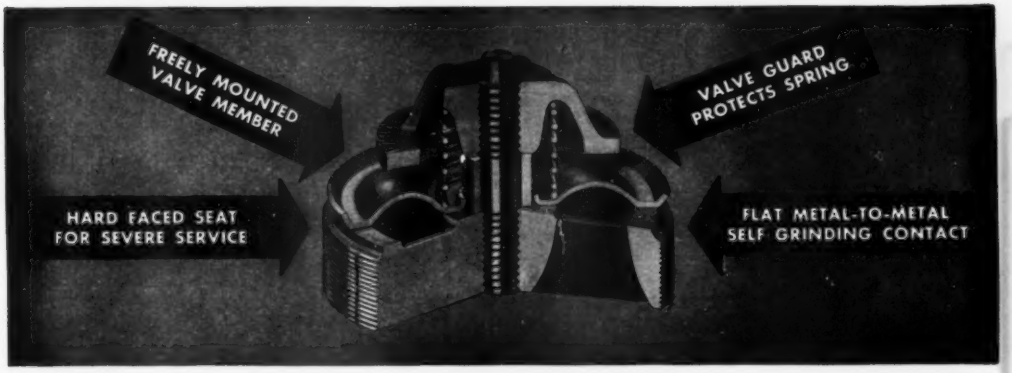
New York Office: Graybar Building

ESTABLISHED SINCE 1910

DIVISIONS
Brick Machinery
Foundry
Industrial Heating
Ironsmith
Shipbuilding
Steel Plate

DURABLA

METAL PUMP VALVE UNITS
KEEP YOUR PUMPS IN SERVICE


FREELY MOUNTED VALVE MEMBER
VALVE GUARD PROTECTS SPRING
HARD FACED SEAT FOR SEVERE SERVICE
FLAT METAL-TO-METAL SELF GRINDING CONTACT

1 **THEY ARE SELF-GRINDING:** Durabla Valve Units*, utilizing the freely mounted arched construction valve member exclusive to Durabla, are self-grinding, as the flat portion of the valve member is in direct contact with the flat valve seat and is free to move about its axis, thus producing a constant self-grinding action.

2 **VALVE SEATS ARE HARD FACED FOR SEVERE SERVICE:** Providing a seat surface hardness of Rockwell C-48-52 (approximately 500 Brinnel) or more in special valves, Durabla Valve Units have a long record of effective service with **FLUIDS CARRYING SUSPENDED ABRASIVE SUBSTANCES.** The metal valve member effectively prevents the pitting or "pick-up" of abrasive substances sometimes occurring with valves made of other materials.

3 **VALVE SPRINGS AND VALVE STEMS ARE PROTECTED:** The Valve Guard protects the Valve Spring from ever compressing more than 50% of its length. The Valve Stem is protected against breakage by the free mounting of the Valve Member.

Economy, efficiency and adaptability, based on long established service records and exclusive design make Durabla Valves your guarantee of reliable, uninterrupted pump operation.

You can specify Durabla Valves when you order a pump, (many manufacturers use them as standard equipment), or you can order Durabla Valves to fit any type of reciprocating pump, (they come with drive-fit seats or threaded seats with or without a shoulder to suit the job).

TO AVOID "PUMP TROUBLES" SPECIFY DURABLA VALVES

Address DURABLA Engineering Department for information and bulletin: Reference OG-3

*Patent Numbers 2090486, 2117504

DURABLA MANUFACTURING COMPANY
114 LIBERTY ST. NEW YORK
BRANCHES IN PRINCIPAL CITIES. FOR CANADA REFER: CANADIAN DURABLA LIMITED, TORONTO

WE MAKE ALL TYPES OF PLUG VALVES

For ALL Kinds of Services
In the Right Metals for Your Needs

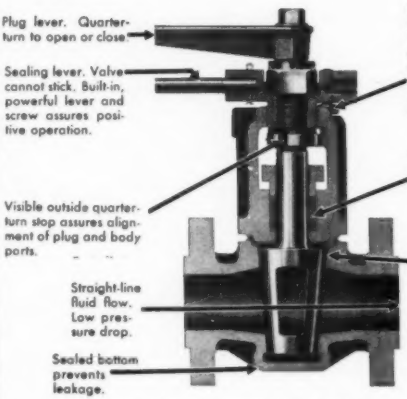
HOMESTEAD
Lever-Seald
Quarter-Turn
PLUG VALVE

HOMESTEAD CAM-SEALD (dry seat)

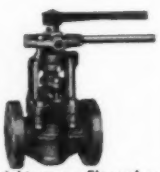
Straight-way— Flanged or Screw Ends

Three-way— Screw or Flanged Ends

Four-way— Flanged or Screw Ends


Plug lever. Quarter-turn to open or close
Sealing lever. Valve cannot stick. Built-in, powerful lever and screw assures positive operation.
Visible outside quarter-turn stop assures alignment of plug and body ports.
Straight-line fluid flow. Low pressure drop.
Sealed bottom prevents leakage.
Positive stop allows seating pressure to be relieved only enough to overcome friction between plug and body and permit easy turning of the plug.
Deep stuffing box and gland. No leakage
"Lever-seald" action presses mated metal surfaces firmly together to form perfect seal against leakage.
Protected seating surfaces. No fluid or grit passes across seating surfaces. Maximum valve life and lowest cost-per-year service.

Sectional View — Homestead Lever-Seald Valve — Closed Position



Straight-way— Flanged or Screw Ends

Three-way— Flanged or Screw Ends

Four-way— Flanged or Screw Ends

HOMESTEAD-REISER (lubricated)

Straight-way— Screw or Flanged Ends

Straight-way— Worm & Gear Operated

Flow Changer— Non-lubricated

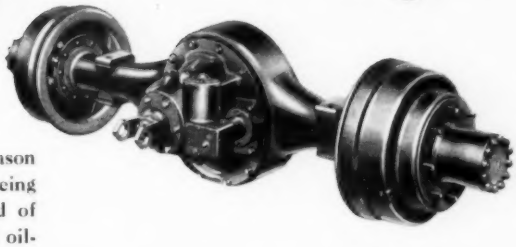
You can end valve-operating difficulties on high temperature, pressure and corrosive services, and on jobs where lubricant would contaminate process fluids, by installing Homestead Lever-Seald Valves. They are stick-proof, because a *built-in* lever and screw device assures positive action at all times, under all conditions. If the service warrants, they may be double-sealed by pressure gun lubrication.

Homestead Lever-Seald Valves are available in straight-way, three-way, and four-way types, with screwed or flanged connections. They may be cast in Semi-Steel, Steel, Ni-Resist, Stainless Steel, Monel, or other alloys; in sizes from 1" to 10"; for vacuum to 1500 lbs., and for temperatures from 40° below zero to 1100°F. For full information, write for Valve Reference Book No. 39-3. No obligation.

Distributors in all parts of the world. For local representative see Classified Telephone Directory.

HOMESTEAD VALVE MANUFACTURING COMPANY
P. O. BOX 403 *"Serving Since 1892"* **CORAOPOLIS, PA.**

exclusive forced-flow lubrication keeps Eaton 2-speeds on the job, makes them last longer



PLENTY OF LUBRICATION—always! That's one reason for the outstanding life and performance records being set by Eaton 2-Speed truck axles in every field of heavy-duty hauling! Eaton's exclusive forced-flow oiling system provides abundant lubrication even at lowest vehicle speeds. The instant gears turn over—even one revolution—oil is started on its way to all moving parts; the rate of flow is governed to meet the demands of various operating speeds. This unique lubricating system and Eaton's exclusive planetary construction are important factors in the ability of Eaton 2-Speeds to stay on the job, to deliver maximum performance with minimum upkeep. Ask your dealer to explain how Eaton 2-Speeds reduce stress and wear on engine and power-transmitting parts—how they will help *your* trucks haul more, faster, longer, at lower cost.

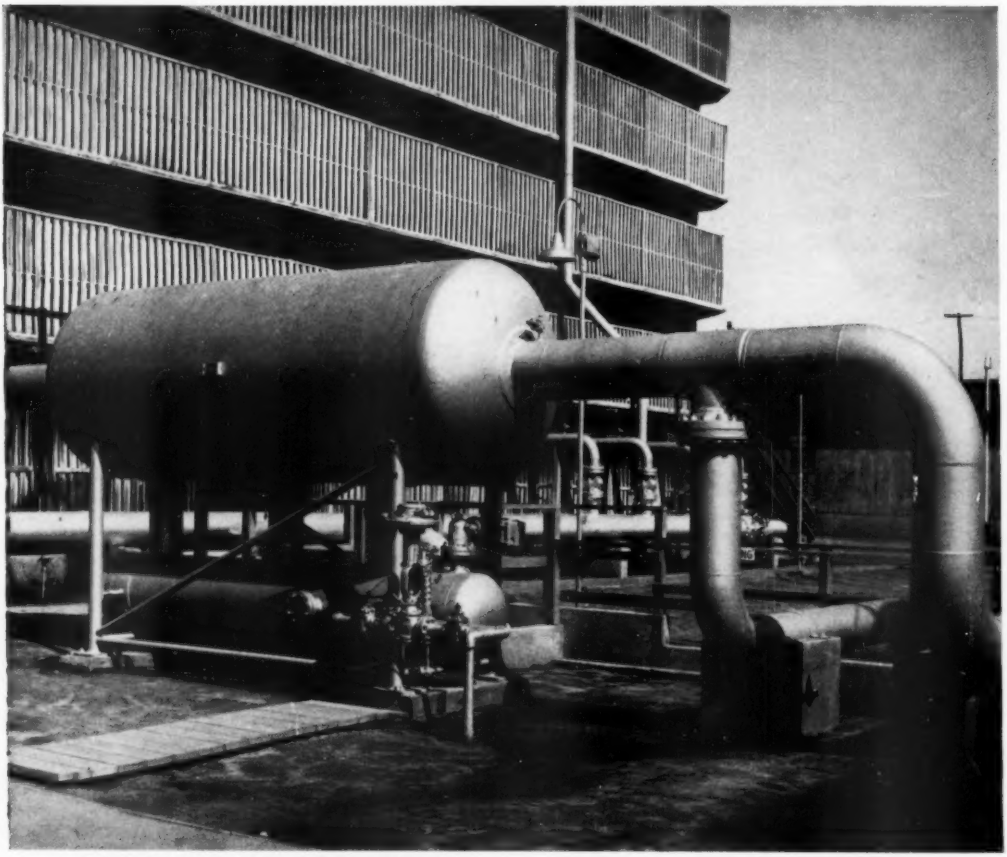
EATON
2-Speed Truck
AXLES

Axle Division
EATON MANUFACTURING COMPANY
CLEVELAND, OHIO

PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers

See PEERLESS FIRST!

For GAS SCRUBBERS...



The **BEST SCRUBBERS** for PIPELINES, GATHERING SYSTEMS, COMPRESSOR STATIONS, PLANT INLET SCRUBBERS

Pictured above is a Peerless 60" O.D. x 15 foot horizontal separator, handling 240,000,000 cu. ft. per day at 350#.

This separator is removing condensed liquid from the cooling tower to prevent moisture accumulation in distribution units.

Consult Peerless for an engineered solution to your most stringent entrainment problems.

PEERLESS MFG. CO.

PEERLESS MANUFACTURING CO.

P. O. BOX 7193 ★ DALLAS, TEXAS ★ DIxon-8431

REPRESENTATIVES IN ALL PRINCIPAL CITIES

They Say—

Item From Illinois

Sirs:

I want to take this opportunity to compliment Philip C. Ingalls for his "Exploration and Drilling" page.

Week after week he gets the meat in the coconut all on one page, on a very newsworthy area, and in a very thorough fashion. I am amazed at his geological knowledge of the whole U.S.A.

It is all I can do to keep up with my own baliwick, but he gives me a bird's-eye view every week of all that's going on, and I think it's swell.

Katharine W. Carmon, Geologist
Evanston, Illinois

Iran and Point Four

"It should still be brought home to the Iranian people that technical assistance is merely a small part of the aid available to them.

"The larger part of that aid must come, however, from private capital investments, which are available to those nations which honor their contracts. For the moment the Mossadegh regime has taken Iran from the list of such nations. But that situation is subject to correction by the Iranian people.

"If the present aid helps them to realize this it will be worth what it costs."

Editorial in the New York Times.

Automobiles' Extra Demands

"You may be interested to know that for every additional car that goes on the road, these days, the oil industry puts up $500 as an investment in new facilities! That's what it takes to provide the producing, refining, and distributing equipment to keep one additional car rolling. It's a staggering total when you consider that, last year, the number of cars in operation went up about 2,400,000. The cost of these new facilities is met by the oil companies themselves."

Dwight F. Benton, vice president, Standard Oil Co. (Ind.), speaking in Chicago.

Financial Squeeze

"Your company, as well as industry generally, is finding it extremely difficult to maintain the financial resources necessary to cover the high cost of replacing raw-material reserves and facilities and at the same time expand its operations.

"Not only are taxes severely limiting the accumulation of capital by industry, but they are reducing the savings of individuals, the basic source

CUT CORROSION PROBLEMS DOWN TO SIZE...

WITH TAPECOAT*

—the Coal Tar Coating in Handy Tape Form
—Sized to the job

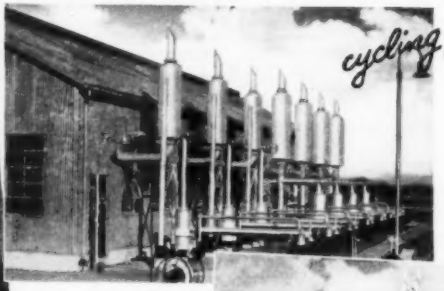
24" WIDTH
TAPECOAT — the economical coal tar coating for "cigarette-wrapping" mechanical couplings, large diameter pipe, joints, bends and drips.
18" WIDTH
TAPECOAT—the practical coal tar protection for "cigarette-wrapping" of large couplings, pipe bends, and joints on large diameter pipe.
6, 4, 3, and 2" WIDTHS
TAPECOAT — the distinctive, time-tested coal tar tape for spiral-wrapping welded field joints, service connections, pipe under streets and sidewalks, and pipe through building walls.

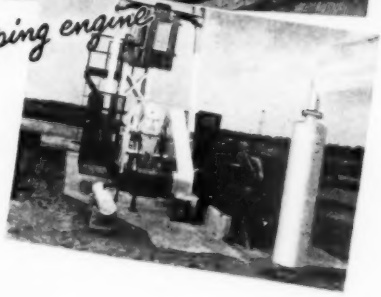
For more than 10 years, Tapecoat engineers have specialized in pipe joint protection. Call on them to help you meet your individual requirements. Write today for complete details.

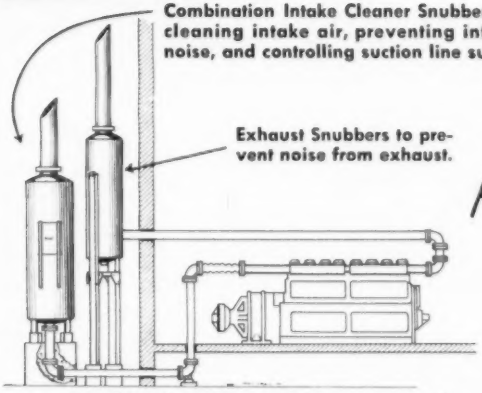
The TAPECOAT Company
Originators of the Coal Tar Tape for Pipe Joint Protection
1539 LYONS STREET • EVANSTON, ILLINOIS

*Reg. U.S. Pat. Off.

From the wellhead through the refinery . . . IT'S BURGESS-MANNING






Combination Intake Cleaner Snubber for cleaning intake air, preventing intake noise, and controlling suction line surge.
Exhaust Snubbers to prevent noise from exhaust.

Typical installation showing Diesel engine equipped with Burgess-Manning Intake and Exhaust Snubbers.

For Quiet Engine Operation

Install BURGESS-MANNING

Combination Air Intake Snubber Cleaners and Exhaust Snubbers

On internal combustion engines everywhere in the petroleum industry, you will find Burgess-Manning Snubbers effectively quieting the thunderous roar of engine exhausts. Likewise, Burgess-Manning Combination Snubber Cleaners on engine intakes reduce the "pumping" noise of intake air without "choking the intake pipe" . . . vibration and air filter fatigue due to pulsing are eliminated. Burgess-Manning is prepared to supply you with Snubbers for any degree of noise reduction your application may require.

For a solution to your engine exhaust and intake noises, consult with Burgess-Manning engineers. For surge control in gas and air lines, write us about our new Gas and Air Line Snubbers.

BURGESS-MANNING COMPANY

DALLAS, TEXAS

of risk capital, and eliminating the incentives for investment.

"Simultaneously, industry is prevented by price control from recovering most increases in cost brought about by inflationary wage increases and taxes."

Annual report, Union Oil Co. of California.

Canadian Supply Economics

"It would be an economic absurdity to ship oil from Edmonton to Halifax, and under normal conditions the cost would be prohibitive to move Alberta oil to Montreal.

"The logical way to serve this area is by tanker from the United States Gulf or South America, or even the Near East ports."

W. M. V. Ash, president, Shell Oil Co. of Canada, addressing the Junior Investment Dealers, Toronto.

CALENDAR

March

Ohio Petroleum Marketers Association, annual convention and marketing exposition, Deshler-Wallick Hotel, Columbus, Ohio, March 18-20.

American Petroleum Institute, Division of Production, Mid-Continent district meeting, Broadview Hotel, Wichita, Kans., March 19-21.

American Association of Petroleum Geologists, Society of Economic Paleontologists and Mineralogists, and Society of Exploration Geophysicists, joint annual meeting, Biltmore Hotel, Los Angeles, March 23-27.

Texas Independent Producers and Royalty Owners Association, sixth annual meeting, Fort Worth, March 27-28.

North Texas Oil and Gas Association, twenty-second annual meeting, Kemp Hotel, Wichita Falls, Tex., March 29.

Western Petroleum Refiners Association, annual meeting, Plaza Hotel, San Antonio, March 31-April 2.

Mid-West Gas Association, annual meeting, Hotel Radisson, Minneapolis, Minn., March 31-April 2.

American Chemical Society, division of petroleum chemistry, annual meeting, Milwaukee, March 31-April 3.

April

Pacific Coast Gas Association, annual transmission conference, Berkeley, Calif., April 2-3.

Oil and Gas Conservation Institute, University of Oklahoma, Norman, Okla., April 2-3.

American Petroleum Institute, Division of Production, eastern district, Hotel William Penn, Pittsburgh, April 2-4.

Florida-Georgia Gas Association, annual convention, Soreno Hotel, Saint Petersburg, April 3-5.

Missouri Liquefied Petroleum Gas Association, Hotel President, Kansas City, Mo., April 7-9.

American Society of Lubrication Engineers, annual meeting, Statler Hotel, Cleveland, April 7-9.

Arizona Geological Society of America, forty-eighth annual meeting, University of Arizona campus, Tucson, Ariz., April 11-12.

Petroleum Industry Electrical Association and Petroleum Electrical Supply Association, twenty-fourth annual joint conference, Mayo Hotel, Tulsa, April 14-17.

American Institute of Electrical Engineers, District 7 meeting, Hotel Jefferson, St. Louis, April 15-17.

Association of American State Geologists,

a complete line of
and
and oil refinery specialty tools
THE AIRETOOL MFG. CO.
NO. 6300 FOR 3" I.D. TUBES
Automatic Airline Lubricator
Electric Tube Expansion Control
Buffing Motor
AIRETOOL is headquarters for the RIGHT tools for fast efficient tube cleaning and tube expanding maintenance. For complete refinery catalog, write The AIRETOOL Mfg. Co., 316 S. Center St., Springfield, Ohio.
There's an AIRETOOL Tube Cleaner and Tube Expander for Every Type of Tubular Construction
SEE OUR CATALOG IN THE REFINERY CATALOG
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New York
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IT'S PACKED
WITH SATISFACTION
WHEN IT'S PACKED
WITH **R/M**

Whatever your packing problem . . . gaskets for a Freon condenser like this one . . . or packings for service against high pressures, high temperatures, chemicals, refrigerants, petroleum, milk or other special fluids . . . Raybestos-Manhattan has a packing or gasket designed for the job. Check your R/M Packing Catalog, or call your nearby R/M distributor.

R/M

PACKINGS

RAYBESTOS-MANHATTAN, INC.

PACKING DIVISION, MANHEIM, PA.

FACTORIES: Bridgeport, Conn.; Manheim, Pa.; No. Charleston, S.C.; Crawfordsville, Ind.; Passaic, N.J.; Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Manufacturers of Packings • Asbestos Textiles • Mechanical Rubber Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Sintered Metal Products • Bowling Balls

annual meeting, Tallahassee, Fla., April 15-19.

National Petroleum Association, semiannual meeting, Hotel Cleveland, Cleveland, April 16-18.

American Petroleum Institute, Division of Transportation, pipe-line conference, Blackstone Hotel, Fort Worth, April 21-23.

American Petroleum Institute, safety and fire-protection committees, Hotel Texas, Fort Worth, April 21-24.

National Petroleum Council, conference rooms A and B of the Interior Department Auditorium, Washington, D. C., April 22.

American Petroleum Institute, Division of Production, Rocky Mountain district, Gladstone Hotel, Casper, Wyo., April 24-25.

Indiana Gas Association, annual meeting, French Lick Springs Hotel, French Lick, Ind., April 24-25.

Ardmore Geological Society, field trip, East of Ardmore and South of the Arbuckle Mountains, April 25-26.

Independent Petroleum Association of America, midyear meeting, Deshler-Wallick Hotel, Columbus, Ohio, April 28-29.

American Oil Chemists' Society, spring meeting, Shamrock Hotel, Houston, April 28-30.

American Institute of Electrical Engineers, District 1 meeting, Binghampton, N. Y., April 30-May 2.

Natural Gasoline Association of America, annual meeting, Rice Hotel, Houston, April 30-May 2.

May

Southeastern Section Geological Society of America, and Southeastern Mineral Symposium, joint meeting, Hotel Roanoke, Roanoke, Va., May 1-3.

National Air Pollution Symposium, Huntington Hotel, Pasadena, Calif., May 5-6.

American Geophysical Union, thirty-third annual meeting, National Academy of Sciences, National Research Council, Washington, D. C., May 5-7.

Texas Petroleum Research Committee, Fourth Oil Recovery Conference, Austin, Tex., May 8-9.

Interstate Oil Compact Commission, spring meeting, Phoenix, Ariz., May 9-10.

American Institute of Chemical Engineers, regional meeting, French Lick, Ind., May 11-14.

American Association of Petroleum Geologists, regional meeting, Mayo Hotel, Tulsa, May 12-13.

American Gas Association, Natural Gas Department, spring meeting, Biltmore Hotel, Los Angeles, May 12-13.

Annual Liquefied Petroleum Gas Association convention and trade show, Palmer House, Chicago, May 12-14.

American Petroleum Institute, Division of Refining, seventeenth midyear meeting, San Francisco, May 12-15.

Pennsylvania Gas Association, Wernersville, Pa., May 13-15.

Intermountain Association of Petroleum Geologists, Third Annual Field Conference, the Basin and Range Province from Cedar City, Utah, to Las Vegas, Nev., May 13-16.

American Petroleum Institute, Division of Production, Pacific Coast district, Biltmore Hotel, Los Angeles, May 15-16.

American Petroleum Institute, division of marketing, midyear meeting, Copley Plaza, Boston, May 19-20.

Gas Appliance Manufacturers Association, annual meeting, Broadmoor Hotel, Colorado Springs, Colo., May 21-23.

American Gas Association, production and chemical conference, Hotel New Yorker, New York, May 26-28.

Southwestern Gas Measurement Short Course, University of Oklahoma, Norman, May 27-29.

Society of Exploration Geophysicists, Gulf Coast regional meeting, Rice Hotel, Houston, May 29-30.

Seventh annual short course in gas technology, sponsored by the Southern Gas Association, Texas College of Arts and Industries, Kingsville, Tex., May 28-30.

June

Society of Automotive Engineers, summer meeting, Ambassador and Ritz-Carlton Hotels, Atlantic City, N. J., June 1-6.

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tion, annual meeting, Hotel William Penn, Pittsburgh, June 5-6.

Canadian Gas Association, Chateau Frontenac, Quebec, June 8-12.

American Petroleum Institute, midyear standardization meeting, Brown Palace Hotel, Denver, June 9-14.

Western Petroleum Refiners Association, regional technical and industrial-relations meeting, Broadview Hotel, Wichita, Kans., June 12-13.

International Gas Conference, Brussels, Belgium, June 16-22.

Kentucky Oil and Gas Association, annual meeting, Hotel Lafayette and Phoenix Hotel, Lexington, Ky., June 19-20.

Petroleum Equipment Suppliers Association, Mark Hopkins Hotel, San Francisco, June 22-25.

Michigan Gas Association, annual meeting, Grand Hotel, Mackinac Island, Mich., June 23-24.

American Society for Testing Materials, annual meeting, Hotel Statler, New York, June 23-27.

American Institute of Electrical Engineers, summer general meeting, Nicollet Hotel, Minneapolis, Minn., June 23-27.

August

Wyoming Geological Association, field trip, Big Horn Basin, August 1-3.

Society of Automotive Engineers, national West Coast meeting, Fairmont Hotel, San Francisco, August 11-13.

American Institute of Electrical Engineers, Pacific general meeting, Westward Ho Hotel, Phoenix, Ariz., August 19-22.

September

Pacific Coast Gas Association, Ambassador Hotel, Los Angeles, September 3-5.

Instrument Society of America, seventh national instrument conference and exhibit, Cleveland, September 8-12.

National Petroleum Association, fiftieth annual meeting, Hotel Traymore, Atlantic City, N. J., September 10-13.

American Institute of Chemical Engineers, regional meeting, Palmer House, Chicago, September 11-13.

Western Petroleum Refiners Association, regional meeting, Hotel Henning, Casper, Wyo., September 25-26.

American Association of Oilwell Drilling Contractors, annual meeting, Skirvin Hotel, Oklahoma City, September 28-30.

October

Independent Natural Gas Association of America, annual meeting, Fontenelle Hotel, Omaha, Neb., October 6.

California Natural Gasoline Association, twenty-seventh annual fall meeting, Ambassador Hotel, Los Angeles, October 9-10.

Texas Mid-Continent Oil and Gas Association, thirty-third annual meeting, Hotel Texas, Fort Worth, October 13-15.

American Institute of Electrical Engineers, fall meeting, New Orleans, October 13-17.

Natural Gasoline Association of America, southern regional meeting, Blackstone Hotel, Tyler, Tex., October 19.

Independent Petroleum Association of America, annual meeting, Mayo Hotel, Tulsa, October 20-21.

American Oil Chemists' Society, fall meeting, Netherlands Plaza Hotel, Cincinnati, October 20-22.

Society of Automotive Engineers, national transportation meeting, Hotel William Penn, Pittsburgh, Pa., October 22-24.

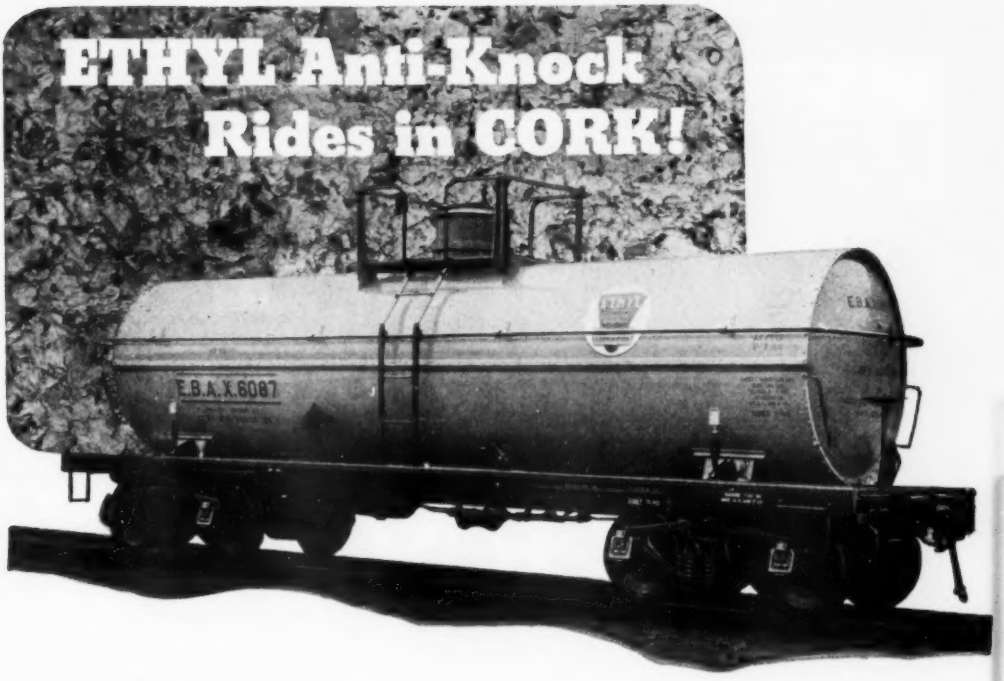
NOMADS

Tulsa Nomads, third Friday of each month. After Five Room, Tulsa Hotel.

Dallas-Fort Worth Nomads, first Monday of each month, Greater Dallas Club.

Houston Nomads, second Monday of each month, Ye Ole College Inn, Houston.

Los Angeles Nomads, second Wednesday of each month, Jonathan Club.



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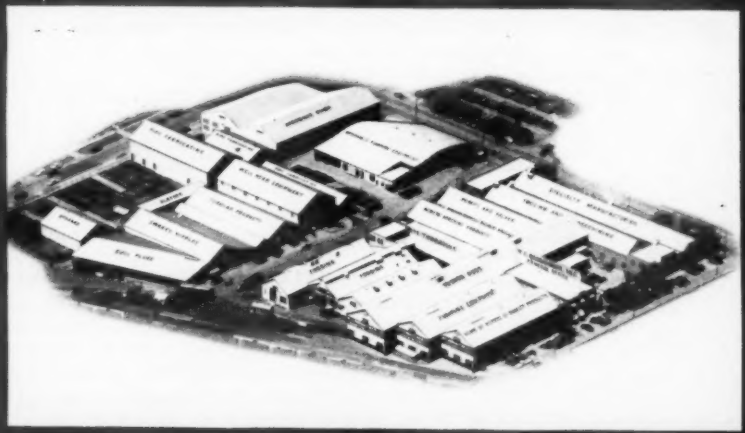

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THE OIL AND GAS
JOURNAL
TULSA, OKLAHOMA

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JOURNALLY Speaking

Illumination, 1862

THIS being the Journal's annual refining issue, this department undertook to contribute something useful to the discussion and so we engaged in our usual exhaustive research.

The source material most readily at hand happened to be a yellowed and musty volume of "The American Annual Cyclopaedia and Register of Important Events of the Year 1862" which the janitor had dumped in our office after cleaning out the basement. Thumbing through it, our eye was struck by the heading "ILLUMINATION, Gas and Oils," from which we lift the following pertinent extracts:

"Of the many uses to which petroleum and its derivatives are applied, that of illumination is the most important; and the process of refining is exceedingly simple. The crude material is put into a large iron retort, connected with a coil of iron pipes surrounded by cold water, called a condenser. Heat is applied to the retort, and from the open extremity of the condenser, a light colored liquid of a strong odor soon flows.

"This is naphtha, and is very volatile and very explosive. Some refiners mix it with the burning oil, and numerous accidents have resulted from such mercenary indiscretion. It is usually run into a separate tank. After the naphtha has passed over, the oil used for illumination distils off. Steam is now forced into the retort and the heavy lubricating oil driven over. There now remains a black, oily, tarry matter, sometimes used to grease heavy machinery, and a black coke, employed as fuel.

"There are, therefore, five substances separated in this operation, but only the first three are of any economic importance.

"The naphtha is used as a substitute for turpentine in paints, or by repeated distillation the benzole is separated from it and employed to remove spots from fabrics. This, however, is rather a drug in the hands of the refiner. . . .

"The illuminating power of paraffine (kerosene) oil is remarkably high. One gallon of Young's paraffine oil, weight about 8½ lbs., will give, according to Dr. Letheby's experiments, the light of 23½ lbs. of spermaceti candles, or of 27 lbs. of wax candles, or of 40 lbs., of the best tallow candles."

The unidentified author of this treatise did, however, realize that a broad avenue of technological progress lay ahead, for he recited experiments in extracting other derivatives of petroleum and concluded that "as this is a comparatively new field, many discoveries may be confidently expected in it in the course of a few years."

Well, 90 years have coursed since the only important product of petroleum refining was valued in terms of spermaceti candles, and the Civil War writers' confident expectations have been fulfilled; but petrochemistry, at which he dimly hinted, still is "a comparatively new field" with "many discoveries" still ahead.

But the many products which this writer foresaw, including gasoline which he didn't, are not produced by a refining process which can be described as "exceedingly simple." If that old boy were around to take a look at the process charts in the special section of this issue he would need a lot more illumination than he could get from 23½ lb. of spermaceti candles.

On the Job

FOR a good many weeks now our favorite oil publication has been running a double truck of pictures and short items under the heading "On the Job," describing bright ideas, clever kinks, and ingenious dohickeys by means of which operating oil men in field and plant have solved some of their everyday problems.

Up to now this feature has been pretty much smack dab in the middle of the Big Yellow Book, but in this issue and henceforth it will be found farther toward the back, surrendering its ringside-seat position to special articles of greater length and more technical nature. Incidentally, you can pick up a little pocket change by sending in material for On the Job items. Never mind about the style of writing; just send us the dope and if we think it will interest other operating men you will get a pleasant and negotiable surprise.

—*Henry D. Ralph*

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In addition, Anchor has, through the years, gained the experience and built the reputation for giving quick, intelligent service. Our men . . . in the field and in the office . . . know their business well. They have the reputation of making promises they can live up to. When you need petroleum products, whether your order is large or small, call Anchor first.

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THE OIL AND GAS
JOURNAL
Vol. 50, No. 45

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• **The Annual Geological Number.** This issue will feature a 22-page section entitled "Introduction to Geophysical Prospecting," by Dr. Milton B. Dobrin, senior research technologist at Magnolia Petroleum Co.'s field research laboratories in Dallas. It also will present a review of geophysical prospecting for 1951, and addresses of the presidents presented at the annual meeting of the exploration societies, and abstracts of the meeting's papers.

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Unless you are using Baker "Whirling" Cementing Equipment, you probably are wasting valuable rig time in *running* and *cementing* casing.

It takes mighty little wasted rig time to pay the difference in cost between ordinary shoes and Baker "Wash-Down Whirler" Shoes which do the *best* possible cementing job in the *shortest* possible time.

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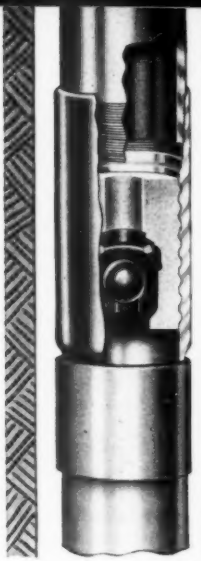
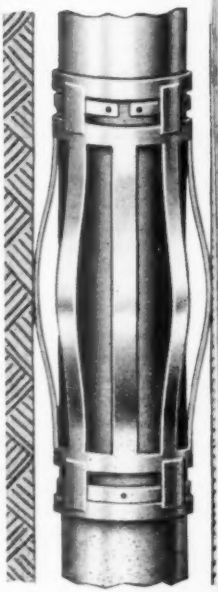
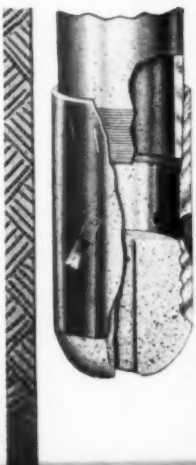


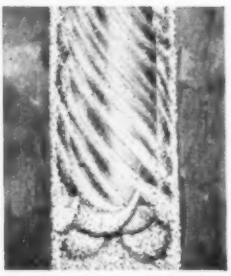




Here is visual proof of what *whirling* does for you...

The downward hydraulicking action of the circulating fluid through the baffled side down-whirler ports and the restricted bottom passageway, effectively remove bridges and permits safe running of the string of casing.

When washing the formation at the cementing point to condition the hole, the "whirling" motion of the fluid helps remove mud cake from side walls. This *downward* whirling is far superior to any *side jetting* action, and does not cause caving or crumbling of soft formations.



The "whirling" motion given to the cement slurry as it is discharged from a Baker Wash-Down Whirler Shoe causes the cement to encase the centered shoe joint with a more uniform body of cement, and reduces to a minimum the hazard of channeling.

Refiners are in the middle in more ways than one

THE refiner is a middle man in the oil industry, the link between the producer of crude and the consumer of petroleum products. As such, his profits are constantly squeezed between the pressure for higher crude prices and the competitive push for lower products prices, so that maintenance of a satisfactory operating margin is a perpetual problem.

The refiner's only way out of this squeeze, in the long run, is the installation of new and more efficient processing equipment. But here again the refiner is in the middle, in the colloquial sense of the term, for he must weigh the rising costs of such installations against the possible returns from a better operating margin.

ACTUALLY the refiner has little choice in the matter of expansion and modern processing equipment, for rising demands of the market make it impossible for the refining industry to stand still. The Journal's latest survey shows that active operating capacity of United States refineries now is 7,312,385 bbl. daily, in terms of crude-oil throughput, and that by 1953 or 1954 it will reach 7,735,000 bbl. daily.

This forecast is on a basis which has proved conservative in the past, and present conditions leave little doubt that the new capacity must and will be provided. But even this rate of expansion may not be enough. The Petroleum Administration for Defense estimates that by the end of 1955 this country will need refining capacity of 8,550,000 bbl. daily to meet the demand for petroleum products then.

So refiners must continue to build and build, to expand, modernize, and improve. They are now in the middle of the biggest construction program in their history and there would appear to be no letup in this activity for at least 2 or 3 years.

IN still another way refiners are "caught in the middle." This is the problem of the so-called middle of the barrel, the group of distillate cuts between gasoline and residual fuel. Demands for these middle cuts have been increasing faster in proportion than demands for the top and bottom fractions.

Complicating this middle-of-the-barrel problem is the growing demand for feed stocks for catalytic cracking processes which upgrade middle cuts into gasoline and petrochemical stocks. This trend accentuates the need for greater use of processes to upgrade residual cuts into middle fractions. Such process improvements require costly equipment but pay off in increased economic value of the products, and thus consumers benefit from technological progress in the refining industry.

There is no middle-of-the-road course for the refiner today. He must modernize and expand, or fall behind the parade.

THIS WEEK

EXPANDING CAPACITY.—Refineries in the United States now have a capacity to handle 7,312,385 bbl. of crude daily and projects building or announced will increase this to 7,735,000 bbl. by 1953 or 1954, according to the Journal's survey in this special refining number.

STEEL—Whether there will be an adequate supply of steel for oil and gas-industry operations is a matter of opinion. . . . The industry, on the one hand, thinks there will be enough. . . . But PAD is not so sure, says the supply situation isn't as good as it appears on the surface. . . . The government agency says steel is plentiful now only because the lack of other materials is holding down consumption. . . .

STRIKE—An uneasy truce exists between labor unions and oil companies. . . . The O.W.I.U. has called off indefinitely its nation-wide walkout. . . . Now the WSB is studying all angles. . . . ¶Most oil operators have felt all along that the strike would be avoided if at all possible, as the Government couldn't afford to have its defense effort interrupted. . . . But the issues aren't settled yet and anything could happen. . . .

RESERVES—Liquid-hydrocarbon reserves in the U. S. are at an all-time high. . . . For the first time in any year the petroleum industry discovered more than 5 billion barrels of additional reserves during 1951, A.P.I. and A.G.A. report. . . . ¶With production of about 2.5 billion barrels of this amount, approximately 2.7 billion barrels have been added. . . . This means that every barrel of oil or cubic foot of gas withdrawn in 1951, was "replaced" twofold. . . .

PROCESSES—Operators using Anglo-Iranian's new "Autofining" process can expect a high degree of desulfurization, not only from crude oil but from a wide range of feed stocks. . . . The process has already been proven and the first commercial unit will go on stream this month at the company's Llandarcy refinery in South Wales. . . .

PRICES—The I.P.A.A. is still pushing its fight for higher crude-oil prices. . . . It has joined with spokesmen for other industries in asking the Senate banking committee to wipe out price controls in extending the Defense Production Act. . . . ¶The major bases for price control—shortage of product or possibilities of runaway prices—just don't exist with respect to oil or natural gas, the I.P.A.A. claims. . . .

CORROSION—A number of new methods are being used successfully in combating corrosion in refineries, N.A.C.E. hears. . . . Constant research will help the battle. . . . ¶Hydrogen sulfide corrosion of tubular goods and well-head equipment in sour-crude and gas wells is associated with alloys of high strength, members advised. . . .

INTERNATIONAL—The next move in the oil-nationalization dispute is up to Iran. . . . Any optimism reported previously apparently is Iranian inspired, as the British see little hope that any acceptable degree of non-Iranian management of the industry will be allowed. . . . ¶Venezuelan expenditures are expected to increase substantially this year. . . .

ACTIVITY—Production of crude and lease condensate averaged 6,424,475 bbl. daily for the week ended March 9, up 62,075 bbl. daily. . . . ¶Completions for the week decreased 29 wells to 840. . . . Wildcat completions totaled 180 wells compared with 196 for the previous week and 126 for the same week last year. . . . ¶Rotary rigs operating in the United States on March 10 decreased 2, to 2,662. . . .

TRENDS—Total major product stocks on March 8 were only 11,404,000 bbl. or 4.8 per cent greater than a year ago. . . . Wide variations in stock changes by districts are reflected in product markets. . . . ¶District 2 stocks are up 12,135,000 bbl. for the year. . . . District 5 stocks decreased 11,127,000 bbl. . . .

NATURAL GAS—No immediate decision is to be forthcoming on the Phillips natural-gas case. . . . Battle lines are forming, with states lining up with the company, to intervene against a court appeal filed by several states and cities to set aside FPC's earlier decision. . . .

Better Sulfur Removal

Anglo-Iranian's new "Autofining" process results in high degree of desulfurization from wide range of feed stocks

George Weber

A NEW catalytic desulfurization process which provides a high degree of sulfur removal from gasoline, naphtha, kerosine, and gas oil, has been developed by Anglo-Iranian Oil Co., Ltd.

The process, known as "Autofining," has been fully proven in extended operations in a 350-bbl. per day pilot plant in England.

The first commercial unit has just been erected at the company's Llandarcy refinery in South Wales and is scheduled to go on stream this month. Capacity of the unit is 3,500 bbl. per stream day.

The Autofining process, employing a fixed-catalyst bed, operates at pressures of 50 to 200 psig. and makes use of a stable sulfur-resistant catalyst which has a long life. Catalyst is regenerated periodically, the on-stream period varying with the boiling range of the feed stock.

A small amount of gas, consisting mainly of hydrogen, is produced in the process and this is recycled. As a result, no hydrogen-manufacturing facilities are required.

Feed stocks. — Anglo-Iranian reports that a wide variety of feed stocks can be effectively desulfurized, ranging from natural and straightrun gasolines through naphthas and kerosines to gas oils and light diesel fuels.

Sulfur removed from the feed stocks is largely converted into hydrogen sulfide. The products are of good color and odor, highly stable, and need no subsequent refining treatment. The yields of liquid products obtained are 99 per cent plus by weight or about 100 per cent by volume.

Straightrun gasoline and naphtha feed stocks having A.S.T.M. end points of up to about 400° F. can be almost completely desulfurized by this process, and at the same time, the motor octane rating is raised by two to three numbers and the lead response is considerably improved. With these feed stocks, catalyst on-stream periods of 800 to 1,000 hours between regenerations are possible. Typical results on Middle East straightrun gasoline and naphtha are given in Table 1.

Kerosines are also almost completely desulfurized by the Autofining process, and catalyst on-stream periods of about 400 hours between regenerations are easily achieved.

Of particular value for certain markets is the improvement in burning properties (i.e., char value) obtained. Pilot-plant results on a Middle East kerosine are given in Table 2.

Straightrun light gas oils (i.e., high-speed diesel fuels) may also be desulfurized.

The degree of sulfur removal is lower than with lighter distillates but in the case of Middle East crudes, gas oils of 0.75 to 1.0 per cent sulfur content can be desulfurized to the extent of 60 to 70 per cent with catalyst on-stream periods of 200 hours. Typical results are reproduced in Table 3.

In some refinery situations it may be more desirable to desulfurize a long distillate and fractionate after processing rather than desulfurize separate products after fractionation.

Results obtained when processing long distillates from Middle East and

TABLE 1—AUTOFINING OF MIDDLE EAST STRAIGHTRUN GASOLINE AND NAPHTHA

	Straightrun gasoline		Naphtha	
Yield, per cent weight of feed	99.5		99.7	
Sulfur removal, per cent	99.1		98.4	
Catalyst on-stream period, hours	800		400	
	Feed	Product	Feed	Product
Specific gravity, 60° F.	0.6957	0.6995	0.7800	0.7788
Gravity, °A.P.I.	71.9	70.8	49.9	50.2
Distillation:				
I.b.p., °F.	81	78	298	284
5 per cent vol. at °F.	104	102	308	303
10 per cent vol. at °F.	116	112	312	307
50 per cent vol. at °F.	200	200	332	329
90 per cent vol. at °F.	269	270	369	369
End point, °F.	299	300	403	408
Sulfur, per cent	0.081	0.0007	0.116	0.0019
Octane number (motor)	60.0	62.3		
Octane number +1.5 ml. TEL/Imp. gal.	69.0	75.0		
Octane number +3.5 ml. TEL/Imp. gal.	75.0	81.0		
Color, Saybolt	ca. 20	30+	ca. 20	+26
Doctor test	Pos.	Neg.	Pos.	Neg.
Corrosion test	Pos.	Neg.	Pos.	Neg.

TABLE 2—AUTOFINING OF MIDDLE EAST KEROSINE

Yield, per cent weight of feed	99.5	
Sulfur removal, per cent	90.0	
Catalyst on-stream period, hours	400	
	Feed	Product
Specific gravity, 60° F.	0.7985	0.7981
Gravity, °A.P.I.	45.7	45.8
Distillation:		
I.b.p., °F.	336	329
2 per cent vol. at °F.	352	345
10 per cent vol. at °F.	365	363
50 per cent vol. at °F.	404	404
90 per cent vol. at °F.	446	448
End point, °F.	471	476
Sulfur, per cent	0.180	0.004
Mercaptan sulfur, per cent	0.016	<0.001
Color, Saybolt	+15	+17
Flash point, °F.	126	106
Odor	Poor	Good
Doctor test	Pos.	Neg
Smoke point, mm.	25	26
Burning test (Institute of Petroleum):		
Consumption, g./hour	20.6	20.1
Char, value, mg./kg.	20	14
Appearance of glass	Gray-brown film	Very faint gray film

TABLE 3—AUTOFINING OF MIDDLE EAST VIRGIN GAS OILS

Yield, per cent weight of feed	99.1	
Sulfur removal, per cent	70.0	
Catalyst on-stream period, hours	210	
	Feed	Product
Specific gravity, 60° F.	0.854	0.849
Gravity† °A.P.I.	34.2	35.2
Distillation:		
I.b.p., °F.	459	248
10 per cent vol. at °F.	520	505
50 per cent vol. at °F.	561	556
90 per cent vol. at °F.	619	612
End point, °F.	662	662
Sulfur, per cent	1.00	0.30
Diesel index	55	55
Aniline point, °F.	160	160
Carbon residue (10 per cent bottoms), per cent	0.11	0.11

† The above inspection data refer to the total liquid product, which contains a very small quantity of light ends. Removal of these light ends is easily accomplished in a simple flashing operation to give a product meeting specification flash-point requirements.

Slaughter (West Texas) crudes in this manner are given in Table 4.

Other materials which may be satisfactorily desulfurized by the Autofining process include the highly aromatic extracts obtained by the solvent extraction of gasoline and kerosine fractions (see Table 5).

The process is not normally applicable to residual fuel oils containing asphalt.

Utilities requirements. — The Llandarcy unit is expected to require 6,600 lb. of 150-psi. steam per hour.

Cooling-water consumption is expected to be 30,000 Imp. gal. per hour; fuel consumption, 25,000,000 B.t.u. per hour; and electric power, 10 kw. per hour.

In the Anglo-Iranian plant the recycle-gas compressor is driven by steam generated in a waste-heat boiler.

Costs and licensing. — Total erected cost of the 3,500-bbl. Llandarcy unit was about £250,000 ($700,000).

The process is covered by patents or patent applications in all major countries and is available for licensing by Anglo-Iranian Oil Co., Ltd.

TABLE 4—AUTOFINING OF LONG DISTILLATES FROM MIDDLE EAST AND SLAUGHTER (WEST TEXAS) CRUDE OILS

	Middle East		Slaughter	
Cut on crude, t.b.p., °F.	212-662		203-662	
Yield, per cent weight of feed	99+		99+	
Sulfur removal, per cent	84.5		81.9	
	Feed	Product	Feed	Product
Specific gravity, 60° F.	0.8005	0.7975	0.8285	0.8220
Gravity, °A.P.I.	45.3	45.9	39.3	40.6
Distillation:				
I.b.p., °F.	193		255	243
10 per cent vol. at °F.	249		302	291
50 per cent vol. at °F.	407		448	437
90 per cent vol. at °F.	594		604	590
End point, °F.	653		639	626
Sulfur, per cent	0.387	0.06	1.15	0.174
Naphtha fraction:				
T.b.p., °F. (i.b.p.)	356	356	356	356
Yield, per cent weight	34.8	37.9	30.1	31.6
Specific gravity, 60° F.	0.7585	0.7600	0.7805	0.7785
Gravity, °A.P.I.	52.6	54.7	49.8	50.3
Distillation:				
I.b.p., °F.	207	199	232	239
50 per cent vol. at °F.	279	276	289	289
End point, °F.	367	361	369	363
Sulfur, per cent	0.081	0.002	0.302	0.0025
Sulfur removal, per cent		97.5		99.2
Octane number (motor)		45.0	47.6	52.3
Kerosine fraction:				
T.b.p., °F.	356-482	356-482	356-482	356-482
Yield, per cent weight	35.7	34.3	25.3	28.4
Specific gravity, 60° F.	0.8085	0.8075	0.8180	0.8170
Gravity, °A.P.I.	43.5	43.7	41.5	41.7
Distillation:				
I.b.p., °F.	372	376	388	379
50 per cent vol. at °F.	418	417	415	412
End point, °F.	480	475	484	459
Sulfur, per cent	0.243	0.015	0.694	0.057
Sulfur removal, per cent		93.8		91.8
Gas-oil fraction:				
T.b.p., °F.	482+	482+	482+	482+
Yield, per cent weight	29.5	27.8	44.6	40.0
Specific gravity, 60° F.	0.8410	0.8440	0.8720	0.8635
Gravity, °A.P.I.	36.8	36.1	30.8	32.4
Distillation:				
I.b.p., °F.	509	507	520	514
50 per cent vol. at °F.	549	541	568	560
End point, °F.	655	639	664	658
Sulfur, per cent	0.89	0.23	1.79	0.384
Sulfur removal, per cent		74.2		78.5
Diesel index		59	46	48

TABLE 5—AUTOFINING OF AROMATIC SO_2 EXTRACTS

	Extract from Middle East naphtha		Extract from Middle East kerosine	
Yield, per cent weight of feed	97.5		97.0	
Sulfur removal, per cent	98.6		92.5	
Catalyst on-stream period, hours	200		200	
	Feed	Product	Feed	Product
Specific gravity, 60° F.	0.836	0.835	0.869	0.864
Gravity, °A.P.I.	37.8	38.0	31.3	32.3
Distillation:				
I.b.p., °F.	239	230	311	286
5 per cent at °F.	246	243	329	318
10 per cent at °F.	248	246	338	327
50 per cent at °F.	264	261	372	369
90 per cent at °F.	293	291	451	451
End point, °F.	325	327	489	496
Octane number (motor)	85.3	87.2		
Aromatics, per cent weight	78.1	76.2	75.5	73.8
Color, Saybolt	+15	+27	0	+22
Sulfur, per cent	0.295	0.004	0.692	0.052

MID-CONTINENT

EASY TO CUT.—This piece of plastic tubing is cut easily with a hacksaw. Robert M. Robinson, mechanical engineer with Shell Oil Co., is at right.

Plastic Pipe Under Tests

Use of glass plastic pipe in a well is being made on an experimental basis by Shell Oil Co. and U. S. Plywood Corp.

A total of 150 ft. of U. S. Plywood's "Glasweld" pipe was run recently as tubing tail pipe at the bottom of the 3,300 ft. Shell 1 Batt A, about 5 miles northwest of Great Bend, in Russell County, Kansas.

The plastic tubing will be left in the hole and examined periodically as it is used during the next year. Steel tubing in the well has had a life of about 2 years due to heavy production of salt water.

The pipe is a reinforced glass polyester laminated tubing. The present limited manufacture is at Palmer, Mass. The pipe has been used by the Navy for lines aboard its ships, but is not yet being generally marketed.

The 2½-in. upset-end tubing run in the Batt well consisted of four joints of ⅛-in. wall thickness and six of $\frac{3}{16}$-in. The ⅛-in. wall size weighs 0.8 lb. per foot; the $\frac{3}{16}$-in., 1.2 lb. per foot.

It has been tested to 4,500 psi. ultimate bursting strength and for continuous use under temperatures up to 275 F., and has a greater impact resistance than steel and approximately the same expansion characteristics.

Reserves at New Peak

Every barrel of oil, cubic foot of gas withdrawn in 1951 was "replaced" two-fold, A.P.I.-A.G.A. committes report

FOR the first time in any one year the United States petroleum industry discovered more than 5 billion barrels of liquid-hydrocarbon reserves in 1951.

With production of approximately 2.5 billion barrels of this amount during the year—about 310 million barrels more than was produced in 1950—the industry wound up 1951 with a net addition to reserves of 2.7 billion barrels, according to special reserve committees of the American Petroleum Institute and American Gas Association.

Gas production during 1951 was nearly 8 trillion cubic feet, an all-time high, yet the net increases in estimated reserves of natural gas was 8.2 trillion cubic feet, for the second largest increase of all time.

The A.P.I.-A.G.A. report points out that the remarkable performance by the nation's oil and gas men means, in round figures, that for every barrel of oil or cubic foot of natural gas withdrawn from the ground in 1951, two new barrels of oil or two new cubic feet of natural gas were found or developed. One of the new units compensated for production and the other accounted for the increase in proven reserves.

Two classes.—Total liquid hydrocarbons are made up of two main classes of liquids: Crude oil and natural-gas liquids. Natural-gas liquids are defined as those hydrocarbon liquids that are gaseous in the reservoir but are obtainable by condensation or absorption.

Natural gasoline, condensate, and liquefied petroleum gases fall in this category. In other words, natural-gas liquids are those heavier hydrocarbon components of the natural gas which may be removed and reduced to the liquid state by various processes which usually take place in field separators, scrubbers, gasoline plants, or cycling plants.

As shown in the thumbnail summary table, proven reserves of crude oil only were estimated at 27.5 billion barrels and natural-gas liquids at 4.7 billion barrels. These represent net increases of 2.2 billion barrels and 0.5 billion barrels, respectively, over 1950's year-end estimates. Texas accounted for roughly 80 per cent of each of these net increases.

How estimates are made.—The A.P.I. and the A.G.A. make every effort to secure fair unprejudiced, and representative opinions of geologists and petroleum engineers with long experience in making reserve estimates. Each year all previously determined factors pertaining to various pools are examined and adjusted in the light of new information.

Estimates of proven reserves of liquid hydrocarbons and natural gas as compiled by A.P.I. and A.G.A. committees apply only to those reserves whose locations and extent have been proven and measured.

They do not include any estimate of oil and/or gas which may underlie the vast untested acreage which appears favorable to the accumulation of petroleum. Nor do these estimates include any petroleum that may be recovered by secondary methods unless these methods have been initiated and definite results indicated. They do not include oil from mined oil shales. Furthermore, they are based on existing economic and operating conditions.

"Total reserves."—It is seldom possible to estimate the total reserves of a field in the year of its discovery. Satisfactory estimates can be made only after there has been sufficient drilling in the field, and, in some cases, adequate production history. Reserves listed as discovered during any current year must be considered only as the reserves indicated by the drilling in that year. Estimated reserves of new pools will be revised in future reports in the light of later developments and shown as "extensions and revisions," just as revisions to prior year discoveries are made in this annual report.

Estimates of proven reserves cannot be used to measure rate at which these reserves can be produced with or without physical waste. Today's known oil can be recovered only over a period of many years and at grad-

TABLE 1—THUMBNAIL SUMMARY OF A.P.I.-A.G.A. REPORT

(Thousands of barrels)

Reserves—	Dec. 31, 1950	Dec. 31, 1951	Increase 1951 over 1950
Crude oil	25,268,398	27,468,031	2,199,633
Natural gas liquids	4,267,663	4,724,602	456,939
Total liquid hydrocarbons	29,536,061	32,192,633	2,656,572
Natural gas (M.M.c.f.)	185,592,699	193,811,500	8,218,801

Production—	1950	1951	Increase 1951 over 1950
Crude oil	1,943,776	2,214,321	270,545
Natural gas liquids	227,411	267,052	39,641
Total liquid hydrocarbons	2,171,187	2,481,373	310,186
Natural gas (M.M.c.f.)	6,892,678	7,966,941	1,074,263

TABLE 2—ESTIMATED PROVED RESERVES OF CRUDE OIL IN THE UNITED STATES

(Thousands of barrels)

	Proved reserves as of 12-31-50 (1)	Extensions and revisions (2)	New discoveries (3)	Production during 1951 (4)	Proved reserves as of 12-31-51 (Cols. 1+2+3 less Col. 4) (5)	Changes in reserves during 1951 (Col. 5 less Col. 1) (6)
Alabama	5,396	3,495		1,031	7,860	2,464
Arkansas	341,709	20,402	2,397	28,050	336,458	—5,251
California*	3,733,562	374,710	7,159	354,561	3,760,870	27,308
Colorado	339,529	11,505	1,945	27,801	325,178	—14,351
Illinois	564,218	140,130	3,782	61,795	646,335	82,117
Indiana	57,372	2,501	1,415	10,621	50,667	—6,705
Kansas	732,187	129,105	44,748	114,094	791,946	59,759
Kentucky	55,871	12,276	665	10,263	58,549	2,678
Louisiana*	2,185,137	271,519	49,662	221,537	2,284,781	99,644
Michigan	78,717	—2,576	2,022	14,050	64,113	—14,604
Mississippi	385,705	31,121	4,103	35,542	385,387	—318
Montana	111,272	3,900	2,360	9,114	108,418	—2,854
Nebraska	9,700	4,731	4,250	2,763	15,918	6,218
New Mexico	591,982	63,788	9,504	53,634	611,640	19,658
New York	58,808	2,500		4,247	57,061	—1,747
Ohio	27,264	2,313		3,141	26,436	—828
Oklahoma	1,396,913	234,888	29,781	185,125	1,476,457	79,544
Pennsylvania	106,360			11,358	95,002	—11,358
Texas*	13,581,642	2,532,377	192,858	991,913	15,314,964	1,733,322
Utah	21,629	3,000	6,400	1,346	29,683	8,054
West Virginia	39,042	2,000	420	2,700	38,762	—280
Wyoming	841,016	180,614	20,785	68,975	973,440	132,424
Miscellaneous†	3,367	399	5,000	660	8,106	4,739
Total U. S.	25,268,398	4,024,698	389,256	2,214,321	27,468,031	2,199,633

*Includes offshore reserves. †Includes Florida, Missouri, North Dakota, Tennessee, and Virginia.

TABLE 3—ESTIMATED PROVED RESERVES OF NATURAL-GAS LIQUIDS IN THE UNITED STATES

(Includes condensate, natural gasoline, and liquefied petroleum gases)
(Thousands of barrels)

	Proved reserves as of 12-31-50 (1)	Extensions and revisions (2)	New discoveries (3)	Production during 1951 (4)	Proved reserves as of 12-31-51 (Cols. 1+2+3 less Col. 4) (5)	Changes in reserves during 1951 (Col. 5 less Col. 1) (6)
Arkansas	52,938	—110	80	1,858	51,050	—1,888
California*	363,387	—4,596		29,475	329,316	—34,071
Colorado	12,921	—521		490	11,910	—1,011
Illinois	26,259	2,006	28	3,721	24,572	—1,687
Indiana	152	13	17	33	149	—3
Kansas	163,578	—14	330	4,325	159,569	—4,009
Kentucky	11,927	369	185	2,003	10,478	—1,449
Louisiana*	643,512	64,775	9,294	32,808	684,773	41,261
Michigan	1,018	89	1	99	1,009	—9
Mississippi	55,897	47	995	4,649	52,290	—3,607
Montana	3,547	79		285	3,341	—206
Nebraska	235	1,808	666	123	2,586	2,351
New Mexico	93,897	44,221	661	8,160	130,619	36,722
Ohio	1,688	94	11	83	1,710	22
Oklahoma	279,903	52,715	4,319	25,812	311,125	31,222
Pennsylvania	2,599	119	59	214	2,563	—36
Texas*	2,496,039	470,160	55,702	144,560	2,877,341	381,302
Utah	194	—128		5	61	—133
West Virginia	8,976	20,845	282	6,182	23,921	14,945
Wyoming	48,987	—3,478	2,543	2,166	45,886	—3,101
Miscellaneous†	9	4	321	1	333	324
Total U. S.	4,267,663	648,497	75,494	267,052	4,724,602	456,939

*Includes offshore reserves. †Includes Alabama, Florida, and North Dakota.

TABLE 4—ESTIMATED PROVED RECOVERABLE RESERVES OF NATURAL GAS IN THE UNITED STATES

(Millions of cubic feet—14.65 psia. at 60° F.)

	Reserves as of 12-31-50	Extensions and revisions	New discoveries	Net change in underground storage	Net production	Total
Arkansas	907,593	27,545	38,965	—4	42,785	931,314
California*	9,760,386	170,711	66,827	—4,317	511,162	9,482,445
Colorado	1,115,473	22,955	24,504	0	24,481	1,138,451
Illinois	229,893	29,795	5,650	0	38,205	227,133
Indiana	31,190	2,520	3,340	297	6,540	30,807
Kansas	13,790,834	76,206	40,971	2,326	452,839	13,457,498
Kentucky	1,330,583	59,386	9,520	—401	73,500	1,325,588
Louisiana*	28,533,266	1,147,998	480,933	0	1,157,166	29,005,031
Michigan	195,074	8,786	230	10,347	11,412	203,025
Mississippi	2,519,206	86,321	35,477	40	201,075	2,439,969
Montana	797,361	69,336	0	3,069	41,659	828,107
Nebraska	44,106	30,947	26,646	0	5,889	95,810
New Mexico	6,990,670	4,785,791	132,187	—2,834	315,835	11,589,979
New York	64,779	100	0	4,814	2,900	66,793
Ohio	658,862	32,527	8,450	30,696	41,400	689,135
Oklahoma	11,634,287	769,182	117,604	10,380	727,116	11,804,337
Pennsylvania	627,171	38,272	33,000	43,012	122,000	619,455
Texas*	102,404,077	5,311,803	1,854,153	1,330	3,918,134	105,653,229
Utah	84,752	8,784	6,154	0	3,845	95,845
West Virginia	1,650,675	147,107	21,900	33,817	182,000	1,671,499
Wyoming	2,194,989	161,115	66,518	179	82,503	2,340,298
Miscellaneous†	27,472	26,419	66,356	0	4,495	115,752
Total U. S.	185,592,699	13,013,606	3,039,385	132,751	7,966,941	193,811,500

*Includes off-shore reserves. †Includes Alabama, Florida, Maryland, Missouri, North Dakota, and Virginia.

ually declining annual rates. Only incorrect conclusions can be obtained by dividing these reserves by the current rate of production.

Mississippi Well Completed

ABERDEEN, Miss.—An important wildcat gas strike near here has been completed by Union Producing Co. for an open-flow potential of 35,000,000 cu. ft. daily plus an estimated 10 bbl. of 55.2°-gravity condensate per million cubic feet.

The discovery is the company's 1 J. T. Sanders, 22-15s-6e in Monroe County 8 miles southwest of Aberdeen.

Production is from the Hartselle sand between 5,186 and 5,274 ft. The well is an old stratigraphic test drilled by Carter Oil Co., and abandoned at 6,060 ft. in the Tuscumbia lime.

Union cleaned out the hole to 5,274 ft. and cemented casing at 5,186 ft. Completion was from open hole below the casing. Production was discovered last November when the well blew wild during cleaning-out operations. *(The Oil and Gas Journal, November 15, 1951, page 117.)*

The discovery is 100 miles northeast of the nearest oil production, in the Pickens area of Yazoo and Madison counties, and about 100 miles north of Heidelberg field of Jasper County.

Strike Truce

Walkout is indefinitely postponed by O.W.I.U.

AN uneasy truce existed this week between the labor unions and oil companies throughout the United States.

The threatened strike was postponed indefinitely and the subject of a 25-cent wage increase and other labor demands was being studied by the Wage Stabilization Board.

It was the second postponement by the unions of the strike deadline, originally set for March 3 and then fixed for March 10. The dispute was turned over to the WSB without the cooperating unions ever having announced specifically what plants or even what areas would be principally affected by a strike call.

In sending the question to the WSB, President Truman referred to "disputes" between the companies and the C.I.O. and "various independent unions and certain local unions affiliated with the A. F. of L." His wording supported the companies' contention that the disputes are local in nature.

The Oil Workers International Union, leader in the strike program, long has sought nation-wide contracts with each major company in preference to bargaining on a plant-by-plant basis.

To date, only Sinclair Oil Corp. has a nation-wide contract with the union covering all of its operations.

Information sought.—The WSB is expected to reach a decision this week on the procedure it will follow in attempting to settle the wage controversy.

Since it came into the picture the board has been endeavoring to gather information on which it can seek a settlement, primarily a complete list of the companies against which the unions are moving, their location, and how they are involved.

Once all the information is in hand the board will meet to determine whether to start with a procedural hearing, at which all parties to the dispute will discuss how it is to be handled, or to bypass that step and immediately set up a panel to get down to cases.

In his order to WSB Chairman Nathan P. Feinsinger the President was able to list only eight companies involved in the dispute—Cities Service Oil Co., Deep Rock Oil Corp., Gulf Oil Corp., Shell Oil & Gas Co., Sinclair Oil Corp., Socony-Vacuum Oil Co., Inc., Standard Oil Co. (Ind.), and The Texas Co. It was recognized, however, that the strike threat hung over a far larger number.

The President's order called for investigation of the issues in dispute by the board and its prompt report to him with recommendations as to

fair and equitable terms of settlement.

A considerable time may be required by the WSB, as evidenced by the many weeks it has devoted to efforts to work out a settlement of wage issues in the steel industry.

Tide Water deadlocked. — The 10-week-old strike at Tide Water Associated Oil Co.'s Bayonne, N. J., refinery was at a stalemate again last week after a near-agreement between union and company representatives.

All issues had been agreed upon except the question of a 3-year contract demanded by the company, and union leaders had agreed to submit this question to a secret vote of the local.

Members of the local, however, could not agree to a secret-ballot election and the company offer expired before a vote was taken.

Tide Water maintained it could not justify replacing certain processing facilities without a firm 3-year contract. Without this, the company said, it is considering transferring its refining operations to some other place "where investments can be made with less risk than at Bayonne."

The company previously had a 2-year contract with the unions; in the current negotiations the union had offered a 1-year contract.

The Bayonne strike did not involve wages; the dispute centered around seniority, closed shop, and other issues.

Transco Program

Expansion depends on FPC, Williams tells analysts

Dahl M. Duff

NEW YORK.—Claude A. Williams, president of Transcontinental Gas Pipe Line Corp., outlined a 4-year, 535,000,000-cu. ft. expansion program for the company here last week but said it depends on Federal Power Commission action increasing the company's rate of return to 6½ per cent.

In a talk before the New York Society of Security Analysts March 12, the Transco president said current rates in the money market made it unprofitable to undertake large-scale expansion based on the now-outmoded 6 per cent return.

The present inadequate rate of return is a problem facing the entire gas industry, and there has been discussion in trade-association committees of presenting a joint industry case to the FPC, he said.

The expansion program which Williams outlined would culminate in 1957 with deliveries into the New York area through two main lines.

If a 6½ per cent return on the investment is granted, the company plans construction in 1953 adding 210,000,000 cu. ft. to daily system capacity and costing $106,000,000; in 1954, the addition of another 100,000,000 cu. ft. costing $50,000,000; in 1955, 125,000,000 cu. ft. costing $57,000,000; and in 1956, the final addition of 100,000,000 cu. ft. which would bring total system capacity to 1,096,000,000 cu. ft. daily.

Seeks rate increase.—Transcontinental now has pending before FPC an application for a rate increase totaling $13,640,000. About 50 per cent of this is due to tax increases against the company, and another 25 per cent to higher operating costs. This increase may have to be put in effect May 1 under bond since the FPC probably will not act by that time, Williams said.

Williams disclosed that Transcontinental has been investigating the possibility of buying natural gas in Mexico. Practically every other major pipe-line company also has been in Mexico City considering Mexican gas. However, Williams indicated Transcontinental probably would draw on this source only as a supplement above contract minimums of companies served by the system.

In the Texas and Louisiana area from which Transcontinental's present supply of gas is taken, Williams said there is today about 30 trillion cubic feet of unpledged gas reserves. Competition for this gas is keen.

Companies are already bidding 15 cents per M.c.f. in Louisiana, and 10 to 11 cents in Texas. Williams said his own belief is that economics of the gas-transmission business probably will level these prices off at about present levels.

No production planned.—Transcontinental is not planning to go into the production end of the business in its own right, he said, but it is possible that the management may cause to be formed a production company, stock in which would be offered to Transcontinental's shareholders. Transcontinental believes it unwise to enter the production business itself because of regulatory problems.

Venezuela Enters Compact

LITTLE ROCK, Ark. — Venezuela has accepted an invitation to become an official observer in the Interstate Oil Compact Commission.

The invitation was extended by the Compact executive committee at its meeting in Oklahoma City February 6. Venezuela becomes the second foreign government to become affiliated with the Compact. The Province of Alberta, Canada, came into the Compact as official observer in 1947.

Gov. Sid McMath, chairman of the Compact Commission, in announcing Venezuela's decision said the new association should "considerably broaden the scope of Compact activities" and predicted Venezuela would profit "from the experience gained through the years by the 22 member states . . . in efficient conservation procedures and practices."

CANADA

Big Year Forecast

Alberta sees oil outlay in excess of $200,000,000

EDMONTON, Alta. — Alberta's oil and gas exploration and development program is second only to that of Texas on the North American continent, Premier Ernest C. Manning told the Alberta legislature in his 1952-53 budget address.

Manning said that last year the petroleum industry spent about $200,000,000 for oil and gas development in the province. The figure this year, he said, is expected to be "considerably in excess of that amount."

Alberta in 1951 produced 45,915,384 bbl. of oil, valued at $116,819,581, compared with 27,149,232 bbl. valued at $80,568,178 in 1950.

Active exploration.—Reporting a substantial increase in the amount of exploratory drilling, Manning said that of 1,237 wells drilled, 451 were exploratory tests and of these 161 were successes and 290 were dry holes. He said that as of February 15, 1952, there were 2,818 producing oil wells in the province with a total daily permissible production of 245,000 bbl.

Acreage in Alberta under exploration and development totaled 73,000,000 acres against 59,000,000 at the start of 1951.

Gas exports.—Manning gave no indication in his address as to whether permits would be granted to export natural gas from the province. A report on available reserves and probable Alberta requirements is awaited from the Alberta Petroleum and Natural Gas Conservation Board. However, with 1952 a probable election year in Alberta and opinion throughout the province strongly divided on the advisability of exporting gas, many political observers believe it will be at least late in the year before a decision on export is reached.

In his budget address, Manning said a substantial increase in the amount of natural-gas exploration and development work was recorded during the past year. He said that many new gas wells in widely scattered areas throughout the province have been drilled to gas-bearing formations and have been capped pending availability of a market.

WEST COAST

Elk Hills Speedup

PAD suggests it as means of meeting crude deficit

WASHINGTON. — The Petroleum Administration for Defense is pressing the Navy Department to speed up production from the Elk Hills naval petroleum reserve.

PAD thinks stepped-up operation of the reserve would help overcome a shortage of crude on the West Coast and at the same time provide a test of the capabilities of the reserve in the event of war.

The desirability of increasing Elk Hills output is based on the inability of the Armed Services Petroleum Purchasing Agency to secure all of its West Coast needs without impairing civilian supply. This has forced the agency to divert its purchases to the Gulf Coast for about 40,000 bbl. daily of products. Present indications, PAD found, are that during the last half of this year the necessary diversion will be in the neighborhood of 80,000 bbl. daily, and it is suggested that Elk Hills production be stepped up to meet that need.

Alternatives.—The present District 5 production of 980,000 bbl. daily represents about the maximum that can be produced under sound engineering practices. Increases in the availability of crude in that area would have to come either from further development of the tidelands, development of an economic means of recovering residual oil reserves in California, the discovery of entirely new reserves, or by shipping crude in.

There are perhaps 2,000,000,000 bbl. of reserves remaining to be developed off the coast of California, but resumption of operations is unlikely until the tidelands dispute is settled. There is no prospect of developing an economic means of recovering the residual oil in the near future. Further, there is no great optimism over the probability of discovering new reserves, and even if new oil is found it would require several years to develop it.

Currently crude is being shipped into the district from Montana, Colorado, Texas, and Borneo. However, the shipments from Colorado and Texas are temporary and soon will be discontinued, while the Borneo crude will be displaced by shipments from Sumatra in the coming quarter. The only other important outside source is in Canada, but the pipe line from Alberta to Vancouver probably will not be completed before the last half of next year. The projected lines from West Texas, if built, would not come into service until even later.

Surplus available.—Meanwhile, PAD pointed out, there is a shut-down surplus of 190,000 bbl. daily of refinery capacity in District 5 of which 100,000 bbl. daily could be put into operation with only minor repairs if crude oil could be made available.

The present tight tanker situation is seen as continuing during 1952-53 and the present tanker-construction program will take several years to provide any appreciable relief.

On this basis, PAD believes that in order to save tanker transportation and utilize existing refinery capacity, the Elk Hills reserve should be authorized to operate at levels required to meet military requirements in District 5. It is pointed out that the reserve could be returned to a standby basis upon the completion of the Alberta-Vancouver pipe line, which will have an initial capacity of 75,000 bbl. daily and an ultimate capacity of 200,000 bbl. daily.

While the Navy must endorse any stepping up of Elk Hills production, it rests with Congress to decide whether it shall be done, since legislation would be required for any change in present policies.

SOUTHWEST

Spraberry Move Opposed

AUSTIN.—Consolidation of all fields which produce from common Spraberry reservoirs in Districts 7-C and 8 of West Texas may be a long way into the future.

Notable opposition was voiced by a number of operators at a recent hearing before the Texas Railroad Commission here, who contended that their fields are separate and should not be grouped under a single name.

However, several operators favor such a move, including Fred W. Shield, Texas Crude Co. and Ted Weiner, Magnolia Petroleum Co., Humble Oil & Refining Co., and Sinclair Oil & Gas Co.

Plymouth Oil Co., Slick-Urschel Oil Co., Blackwood & Nichols, Seaboard Oil Co. of Delaware, and Tex-Harvey Oil Co. were among those opposing such a move.

Atlantic Refining Co., while stating it did not object to combination of its Weddell Spraberry field with other production, felt there is insufficient data to justify such action.

A spokesman for Seaboard argued that on the basis of data already supplied the commission, Spraberry Deep field should be maintained as separate. A Tex-Harvey representative voiced the opinion that Tex-Harvey Floyd sand field constitutes a separate reservoir, but suggested that if it were included with other production, that the term "Tex-Harvey" be used to designate the area.

Magnolia said that Driver, Germania, Midkiff, Tex-Harvey, Aldwell, Pembrook, North Pembrook, and Weiner Floyd fields constitute a common reservoir and should be combined under the term "Spraberry Trend."

Humble said it believes all Spraberry production as far north as the north line of Midland County constitutes a common reservoir and should be carried as such.

Billion-Dollar Mark Near

HOUSTON.—Humble Oil & Refining Co. will pass the billion-dollar mark sometime this summer in its expenditures for new facilities since the end of World War II.

Hines H. Baker, company president, said expenditures this year will total $245,000,000, about 30 per cent above the former record outlay of $188,000,000 last year.

Humble has spent $872,000,000 in the 6-year period since the end of the war. However, Baker said, the company isn't getting as much for its money as it has in the past. He cited cost of the average well drilled by the company last year, $81,500, as being more than three times as high as its equivalent drilled 10 years ago.

Humble's tax payments last year came to $85,000,000, Baker said.

General Sells Interests

DALLAS.—General American Oil Co. has sold its gas interests in 80,000 acres of the San Juan basin to El Paso Natural Gas Co. for about $1,300,000.

General American retains a quarter interest in the area free of development costs but subject to prorated operating expenses.

The arrangement, under which El Paso paid $500,000 cash and will pay the remainder out of gas sales, provides that General American will sell all of its gas discoveries to El Paso, which in turn will sell any oil discoveries to General American.

Both El Paso and General American plan to continue their drilling programs in the area.

Humble Opens New Building

MIDLAND, Tex.—Humble Oil & Refining Co. last week formally opened its new, 4-story office building here which will house its West Texas division office.

The building contains 48,000 sq. ft., and the foundation was designed to permit addition of three more stories.

What About Steel?

Industry says it will be plentiful, Government insists that the supply situation isn't as good as it appears

Bertram F. Linz

WASHINGTON.—A running fight between industry and the government has left the nation confused as to just what is the outlook for steel supplies.

Industry for some weeks has been contending that the easing of supplies which recently has developed is permanent, inferring that there will be so much steel available soon that there won't be places to use it all.

But defense-agency officials assert that the steel is plentiful only because the lack of other materials holds down steel consumption—a situation that may change next fall when steel demand is expected to reach its peak.

PAD's view.—Officials of the Petroleum Administration for Defense—industry men who would welcome the elimination of controls as much as the next fellow—side with the government position.

They see no prospect for more than enough steel to keep things going this year and well into 1953. They do see, however, a real probability that oil-country tubular-goods supplies are due for a slow but steady increase. This increase, by the end of the year and through 1953, should keep pace with the expanded industry program mapped out on the basis of reports or the plans of individual companies—the so-called 80,000-well program.

The outlook for the steel needed by the refining branch of the industry is less clear, due to the fact that so far the demand for equipment developed by the expansion program now under way has been light. But when that demand comes into full bloom it will be heavy, and it will take some figuring to find the steel.

Predictions of operators that the industry would have more than sufficient steel within a matter of months are dismissed in Washington as without foundation. The over-all inventory position of the industry will be better on April 1 than it was on January 1, but that will be because the first quarter traditionally is the low period of the year so far as drilling operations are concerned.

Fabricating shortage.—Actually, the shortage which has plagued the industry over the past 18 months has been less a shortage of basic steel than a lack of fabricating facilities. It is principally through the expansion of these facilities, not of raw-steel production, that this situation will be remedied.

Defense Production Administration officials who parcel out steel among the nation's industries have consistently contended that all the oil-country tubular goods that could be produced by the domestic-steel industry has been allotted to the oil program. About seven-eighths of this has been reserved for the domestic industry, which was sufficient last year to permit the drilling of some 45,000 wells.

Even if more steel had been available, they declare and PAD officials concur, it would not have been possible to provide more tubular goods.

Capacity uncertain.—Just what the national capacity for the manufacture of tubular goods might be appears to be an undecided point.

DPA estimates this capacity at 517,000 tons a quarter, but there is other fabricating capacity which may not have been used to full extent. It is from these plants that the so-called conversion goods has been obtained, and DPA experts estimate their capacity may run to 33,000 or more tons a quarter.

Immediate measures.—For the long haul, an increase in the supply of tubular goods is based on new facilities now under construction, but both PAD and DPA are seeking more immediate means to boost availability.

To that end they have been studying the possibilities of so-called mechanical tubing, cylindrical goods used principally in the manufacturing of machinery. There are two types of this tubing—seamless, for which fabrication facilities are available but which would require tube rounds currently in urgent demand; and electrically welded, for which fabricating facilities are available and to which plate and strip tonnage could be diverted.

Some small use already has been made of mechanical tubing, and it is believed it can meet oil-industry specifications. It would be more expensive than regular tubular good; and would require threading outside the production plants, but it is believed as much as 100,000 tons a quarter can be made available if it proves usable.

This would, of course, be merely a temporary expedient to be dropped when production facilities for regular tubular goods become available, but it will be offered operators in the last half of this year and is seen as making possible the slow increase in over-all supply of tubular goods which PAD foresees.

New production.—Meanwhile, five projects for the production of oil-country tubular and other goods are under way, the first of which is expected to start production in the final months of this year at the rate of 30,000 tons a quarter. The other four projects are not expected to be finished for another year. When all are in operation they are expected to boost tubular-goods output by 20 to 25 per cent.

The additional supply which will be secured through the use of mechanical tubing and new fabricating facilities will be greater in proportion than tonnage figures alone would indicate. Both will center largely upon the small-diameter sizes of which the industry is in such need. These sizes are not adequately represented in the production patterns of present mills which were laid out when the use of larger sizes was proportionately greater.

Price Rise Sought

I.P.A.A. tells committee crude controls should end

WASHINGTON.—Declaring there is no need or justification for price ceilings on crude oil and natural gas, the Independent Petroleum Association of America joined with spokesmen for other industries last week in asking the Senate banking committee to wipe out price controls in extending the Defense Production Act.

A brief already submitted to the Office of Price Stabilization was filed with the committee by Russell B. Brown, general counsel of the association, who explained that the major bases for price control—shortage of product or possibilities of runaway prices—do not exist with respect to oil or natural gas.

Brown told the committee that the present act gives the President discretionary authority to exempt commodities from price control whenever such action is necessary to promote the national defense or price controls are unnecessary, and asked that Congress make this exemption mandatory and establish standards to assure that it be applied.

"This matter is of such importance to the defense effort that it should not be left to the discretion of the agency concerned only with price-control authority," Brown declared.

Not recognized — Brown contended

WATCHING WASHINGTON

Bertram F. Linz

Avgas Shortage to End

The aviation-gasoline shortage may be over in less than 6 months.

If no significant increases in demand develop, outstanding PAD orders reserving alkylates for high-octane aviation fuel and requiring an increase in the tetraethyl-lead content of commercial aviation gasoline may be relaxed or revoked.

Adopted as the only alternative to rationing civil-aircraft fuels or restricting deliveries to the military, PAD Order No. 4 was issued last October 19, placing a floor on the lead content of commercial avgas for domestic consumption.

The order has been under attack by airline operators because of the tendency of high TEL content to cause increased engine deposits. This was recently investigated by the House interstate commerce committee with a view to learning whether it may have had anything to do with recent plane disasters, notably the series of three crashes at Elizabeth, N. J.

While PAD officials do not agree with the operators as to the magnitude of the adverse effects of increased TEL, they admit that it requires more careful maintenance work and the order should be removed as soon as possible.

The supply situation has been steadily improving over the past 4 months and should be in balance by the end of the third quarter.

Tidelands Wrangling

Final Senate vote on the tidelands legislation may come late this month, but the first 2 weeks it was up for consideration saw no progress toward a determination of any of the fundamental issues.

The Senate recently wrangled over the measure for several days, then laid it aside to take up President Truman's reorganization plan for the Internal Revenue Bureau and the Japanese peace treaty.

Meanwhile, a group of Texas high-school students who recently corresponded with the Government now probably know the danger of using words loosely. In this case the word was "tidelands," popularly used, even by the Senate, to describe the submerged lands below the low-water mark of the coastal states.

The lesson in English was given by Mastin G. White, solicitor for the Interior Department, and it was neatly summed up in a department release, thusly:

"Members of a history class in a San Angelo, Tex., high school, who had telegraphed to President Truman saying that their class 'definitely believes that the tidelands are a part of Texas public lands' and urging the President to 'please study our side of the case before you decide,' were informed today in a letter from Secretary of the Interior Oscar L. Chapman that their belief is entirely justified and that 'no responsible official of the federal Government has ever asserted any claim on behalf of the United States to Texas tidelands.'"

Thereupon White delivered the punch line. The tidelands, he said, are those between the high and low water marks along the coast.

White undoubtedly is right, but the men who write the digest to the Congressional Record probably will continue to refer to the submerged oil lands as the "tidelands."

Phillips Case Drags On

Present indications are that it will be at least a year before the Supreme Court renders a final decision on the Federal Power Commission decision in the Phillips Petroleum Co. case.

The FPC decision holding that Phillips was not a natural-gas company within the meaning of the term used in the Natural Gas Act was handed down last July. Currently it is before the District of Columbia Court of Appeals where it has been challenged by the cities of Detroit, Kansas City, and Milwaukee; the State of Wisconsin, the Wisconsin Public Service Commission, and the county of Wayne, Michigan.

The preliminary moves in the court case will take up the next 4 months, making it unlikely that it can be docketed for argument before next fall. Several interventions already have been filed with the court, among them for Phillips, which is in the middle, and the State of New Mexico and the New Mexico Oil Conservation Commission.

When the court reaches a decision, and regardless of how it goes, the matter will go to the Supreme Court. An early decision might make it possible to get a review during the 1952-53 term, with a final opinion 12 to 15 months from now, but it's a fair bet the proceedings may extend into 1954.

that crude costs and prices present peculiar problems that have not been recognized by OPS, which he charged has prescribed impractical methods and procedures. Specifically, he said, these methods and procedures are designed for individual cases whereas the basic issue as to petroleum prices is the general level, not individual ceilings, necessary to effect the objectives of the act.

Continuance of present ceilings, Brown said, will make it impossible for the industry to carry out the greatly expanded exploration and development program mapped by the Petroleum Administration for Defense because they eliminate the "reasonable economic incentives and a favorable climate" for investment.

"To enable the petroleum industry to meet its responsibility in providing adequate supplies and to assure the attainment of the objectives of the Defense Production Act, it is recommended that Congress in extending the act establish such standards as are necessary to make mandatory the exemption from price controls where such exemption is necessary to promote the national defense or where price ceilings are unnecessary to effectuate the purposes of the preparedness program," Brown told the committee.

Product Exports Gain

WASHINGTON.—Exports of major oil products averaged 189,600 bbl. daily during the week ended February 15, according to preliminary figures released by the Petroleum Administration for Defense.

The February 15 report showed that exports of distillate were more than double those of the preceding week and there was an increase of 3,500 bbl. daily in motor gasoline shipments, while exports of aviation gasoline and residual declined. For the first time in 3 weeks a small export of kerosine was reported.

The week's exports of the several products, compared with the preceding week and the average for 4 weeks ended February 15, are shown in the following table (in thousands of barrels daily):

	Week ended		Four weeks ended
	Feb. 15	Feb. 8	Feb. 15
Aviation gasoline	15.4	26.7	34.2
Motor gasoline	28.0	*24.5	23.2
Kerosine	4.9		4.9
Distillate	71.4	34.5	61.1
Residual	69.9	80.6	58.7
Total	189.6	166.3	182.1

*Revised

Fuel-Oil Rule Change Urged

WASHINGTON.—Adoption of a change in the regulations governing the price at which oil companies may sell Navy special fuel oil to the Government has been recommended

to Price Stabilization Director Ellis G. Arnall by the Petroleum Administration for Defense.

The modification would be in the form of an adjustment provision permitting a higher price than that prescribed by the OPS February 15 in Supplementary Regulation 5 in the event that the cost of the product to the individual refiner exceeds the controlled price. Similar provisions are contained in many other OPS regulations, it was pointed out.

The OPS ceilings are $2.20 per bbl. in the San Francisco Bay area, $2.15 in California south of San Francisco, $2.10 on the Gulf Coast, and $2.70 at New York, Philadelphia, and Baltimore *(The Oil and Gas Journal, February 25, page 113)*.

PAD Policy Upheld

House small-business committee gives agency clean bill of health in its allocation of oil-country tubular goods

WASHINGTON.—The House small-business committee has endorsed the basic policies followed by the Petroleum Administration for Defense in its allocation of oil-country tubular goods.

The committee feels, however, that the allocation procedure can be improved and made specific recommendations to that end in a report sent to the House by Committee Chairman Wright Patman of Texas. The report was based on the investigation and hearings held last month by a subcommittee headed by Rep. Clarence G. Burton of Virginia *(The Oil and Gas Journal, March 3, page 50)*.

Recommended changes.—To improve allocation procedures, the committee suggested that:

1. The division of operators into A and B groups be based upon footage drilled during their history period rather than upon the number of wells drilled.

2. The smallest figure of the three following criteria be used as the "A" factor in making individual allocations: (a) the PAD "A" factor, corrected for programed depth; (b) the "history tons per thousand feet" corrected for programed depth, or (c) the "programed tons per thousand feet."

3. All the adjustment factors currently used be reanalyzed to determine whether or not the values assigned these factors are proper and whether or not the area to which each factor is applied includes all counties with similar operating conditions.

4. An analysis be made of other areas (such as the Rocky Mountain, Indiana-Illinois, and the Mid-Continent areas) to determine whether or not adjustment factors should be devised for those areas.

5. PAD promptly and fully advise the members of the oil-producing industry whenever changes are adopted in the methods or formulae for making allocations. This should not present a particularly difficult problem because the oil-producing industry includes a relatively small number of individual members in comparison to other industries affected by various control programs.

6. Every effort be made to provide facilities which will enable the small oil producer to receive "on the spot" assistance and that careful study be given to the possibility of utilizing existing field offices of the Department of Interior and the Small Defense Plants Administration in meeting this need.

PAD will consider the recommendations and report its determinations to the committee.

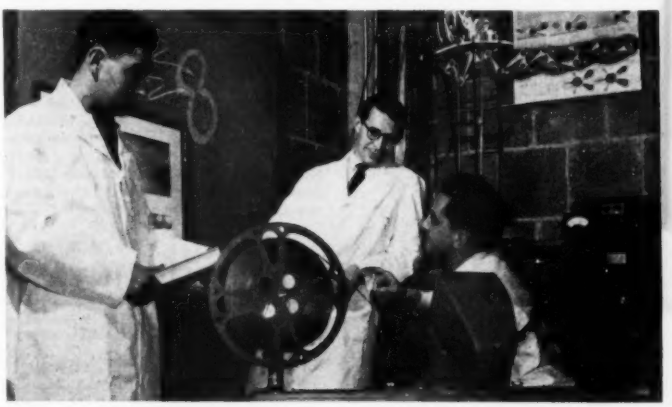
Efforts praised.—"The committee has been impressed by the sincerity of purpose of the officials of the Petroleum Administration for Defense," that report declared. "Many of them are from industry on loan to the government during this period of emergency. These officials have freely admitted that mistakes have been made—mistakes that are to be expected in a program of such scope—but nowhere has the committee found evidence of favoritism or actions dictated by self-interest.

"Neither has the committee found any reason to question the good faith or integrity of the members of the petroleum-producing industry. This industry has shown due diligence in responding to the call of service. Members of the industry are within their rights in demanding to know the determinations which govern the allocation of materials vital to their very existence.

"They also have a right to know whether their competitors have or will receive, either by accident or design, an undue competitive advantage by way of the administration of the government's control program.

"Particularly the smaller units in the industry, often without recourse to the accepted pressure tactics, are entitled to have a program reach out to them rather than undergo the hardships of endeavoring to learn by the trial and error methods the necessary steps to be undertaken."

So far as basic policies are concerned the committee had nothing but praise for the agencies which have to deal with industry needs. It found that the Defense Production Admin-



Reservoir Fluids Star in this Movie

The movement of oil and water through an underground formation, long something of a mystery, can be better understood by this film just completed by the University of Oklahoma after 3 years of work on a research project sponsored by the American Petroleum Institute. The flow of various fluids through synthetic "cores" of tiny glass beads was photographed in color through a microscope. The film was animated with arrows and labels, and the conditions were described on a sound track. Here Dr. Alfred Chatenever, seated, discusses the movie with Robert Overhuls, research assistant, and Melih Genca, Turkish graduate student, left. In an early issue of The Oil and Gas Journal, Dr. Chatenever will describe the next step in O.U.'s reservoir research—forcing liquid paraffin into a salt core which is then dissolved away to reveal the flow patterns of the liquid.

istration, PAD, and the National Production Authority are working together to increase production capacity for oil-country tubular goods and are encouraging the utilization of such substitutes as mechanical tubing to augment supplies while new fabricating plants are building.

Shipments cut.—Also, it pointed out, DPA, PAD, the Mutual Security Agency, the Defense Department, and the Office of International Trade are seeking to discourage, without prohibiting, the transshipment of oil-country tubular goods with a view of ultimately cutting exports and imports to the minimum required for the maintenance of satisfactory trade relations.

"That these efforts are bearing fruit is shown by the reduction in imports from an estimated maximum of 200,000 tons per year in 1949 to an estimated 75,000 tons per year at the present time," the report commented, explaining that 85 per cent of the tubular goods exported now is channeled to the Western Hemisphere, the most important foreign area from the standpoint of national defense.

Present imports are mostly in small gages of pipe and tubing and are necessitated by the extreme shortage here. Exports are of large-gage tubular goods for which there is a lesser demand by the domestic oil-producing industry.

Procedures outlined.—The report outlined in detail the standards and procedures followed by PAD in handling allotments and came to the conclusion that "the personnel of PAD have consistently attempted to allocate oil-country tubular goods fairly and impartially within the limitations imposed by a formula which, of necessity, had to be developed through trial and error."

"As could be expected, in the administration of an involved formula by an organization in the process of development and working under high pressure, numerous mathematical errors were made," it added. "However, the inequities arising from these errors were corrected as soon as discovered, and, because of frequent changes in the methods used in determining the allocation of oil-country tubular goods, the inequities resulting from the mathematical errors were automatically wiped out and were not cumulative."

Defense Orders Changed

WASHINGTON.—The following orders have been changed or issued by the National Production Authority:

Revocation of M-4A, March 6: Basic construction order, supplanted by new orders.

M-100, March 6: Basic regulations on housing construction.

Amendment to M-79, March 6: Including machine-tool replacement parts in maintenance, repair, and operating supplies for export.

M-101, March 7: Controlling the distribution of used and imported metalworking equipment.

Revocation of M-15, March 7: Zinc-control order supplanted by revised M-9.

Revocation of M-37, March 7: Zinc scrap order supplanted by revised M-9.

Revision of M-9, March 7: General zinc order revised to include provisions of M-15 and M-37.

Gas Council to Meet

WASHINGTON.—The Gas Industry Advisory Council is meeting this week with officials of the Petroleum Administration for Defense to review the materials situation and consider the advisability of extension or modification of PAD Order No. 2, which limits the extension of natural-gas service in areas of potential shortage.

The council also is scheduled to receive a report from the gas-planning division of PAD and a report on PAD's experience in providing for defense-plant loads of natural gas.

Washington Briefs

Edwin G. Moline, formerly of the petroleum-policy staff of the State Department, has been assigned to the American Embassy in London where he will handle problems involving petroleum. He is expected to take over his new post in June.

G. Barrett Herr of Pittsburgh, on leave from the Peoples Natural Gas Co., has been named deputy director of PAD's gas-facilities division and on April 17 will succeed Louis C. Sonnen as director of the division. Sonnen, who will have completed a 1-year tour with PAD, will return to his post as vice president in charge of purchasing for the Tennessee Gas Transmission Co.

ROCKY MOUNTAIN

Surge in Drilling Noted

DENVER.—Exploratory and development drilling in the Rocky Mountain area is increasing all the way from the Williston basin to New Mexico, and industry estimates predict that a third more wells will be drilled this year than last.

Fifty new locations have been announced in the area for the week ended March 8, with Wyoming claiming the lion's share of 27. The Denver-Julesburg basin reported 15 new locations, while the remainder were distributed in Montana, the Dakotas, northern New Mexico, and Utah.

Pure Oil Co. has staked location for an 11,000-ft. Lakota test in the Schoonover area of Johnson County, Wyoming, in the Powder River basin. Empire State Oil Co. has located a wildcat in East Muskrat, in Fremont County. Seaboard Oil Co. of Delaware and Superior Oil Co. are starting a venture in South Derby, in the Orin area of Converse County, while Husky Oil Co. has staked a new test in the Five Mile area of Big Horn County about 3½ miles northeast of its recent discovery.

Wage Hearings Set

CASPER, Wyo.—The first steps toward raising the ceilings on wages of drilling crews in the Rocky Mountain area will be taken here March 27 at a hearing called by the Wage Stabilization Board.

Ceilings already have been raised 20 cents an hour in the Southwest *(The Oil and Gas Journal, February 11, page 75).*

The hearing will be conducted by a five-member WSB panel. Dr. Edward J. Allen, regional WSB chairman, said the panel would consider revision of existing policies to maintain the historical difference between Rocky Mountain wages and those of other areas, development of policies on "fringe" items, and possible revision of policy on travel allowances for drilling crews.

Commission's Death Sought

DENVER.—Union Pacific Railroad Co. and Sharples Oil Co. have filed suits in District Court here asking that the year-old Colorado Oil and Gas Commission be abolished.

Both companies asked the court to hold unconstitutional the act creating the commission.

The suits resulted from a commission gas-flaring order for Rangely field which set a maximum on the amount of gas a well might produce without waste and which ordered operators to agree on a program to prevent waste.

Union Pacific claimed it suffered "substantial" loss and was deprived of its property without due process of law.

Bonanza Drilling Planned

LOS ANGELES.—Tevis F. Morrow has announced plans to drill an additional 40 wells on the Bonanza structure near Worland, Wyo.

Morrow, who operates in Texas, California, and the Rocky Mountains, recently purchased Bonanza Oil Co. from Dr. Victor Ziegler and others for nearly $19,000,000.

Headquarters of Bonanza, of which Morrow is now president, have been moved to Los Angeles. Morrow said several exploratory wells, in addition to the development wells, are planned in areas not yet proved.

Corrosion Control

Thanks to research, many new methods are now being used successfully to combat refinery corrosion, N.A.C.E. told

F. Lawrence Resen

GALVESTON, Tex. — High-molecular-weight, organic-corrosion preventives which form a protective film over metal surfaces show promise in combating refinery-corrosion problems, members of the National Association of Corrosion Engineers were told at a refining symposium during the eighth annual conference and exhibition here.

George E. Purdy, Tretolite Co., St. Louis, described the inhibitors which provide a superior method of corrosion mitigation and lessen the requirements for strict pH control. In addition, the preventive acts as an excellent detergent which prevents salt and solid deposition on heat-exchanger equipment.

Results were shown which were obtained during treatment of a debutanizer-feed heat exchanger and also when the inhibitor was injected into overhead vapor of a topping still for the protection of overhead lines.

Purdy's paper also presented application of the inhibitor and results obtained for such process equipment as a debutanizer, atmospheric tower, and complete refinery thermal gas plant.

Industrial painting. — The protective life of a maintenance paint system will be increased up to fourfold if the surface is prepared by blasting rather than wire brushing, according to Robert R. Pierce, Pennsylvania Salt Manufacturing Co., Philadelphia. Furthermore, regular schedules of paint inspection and repair can reduce annual cost of plant protection to the magnitude of 5 cents per square foot, even in aggressive chemical-industrial areas.

Basing his paper on a continuing research program to determine factors and materials which promote maximum protective life in chemical-industrial painting. Pierce said that more than 60 per cent of industrial-maintenance paint compositions have proven inadequate in a chemical-industrial atmosphere. Maintenance paint thicknesses below 5 mil. were found undependable in aggressive chemical-industrial environments.

During the research program, actual and projected life expectancies of various painting systems and procedures were determined and converted to direct dollar costs and savings.

Steam condensate.—The study of corrosion in steam-condensate systems can be facilitated with the use of a laboratory method described by Harold I. Patzelt, National Aluminate Corp., Chicago.

A synthetic condensate is produced in a glass tower by aerating heated distilled water with a mixture of carbon dioxide and air. The condensate and the inhibitor are placed in a test container and steel test coupons are suspended and checked periodically for weight loss.

The temperature, free CO_2, dissolved oxygen of the synthetic condensate, and treatment concentration are all controlled throughout the test.

Sulfur corrosion.—E. N. Skinner, Jr., and W. Z. Friend, International Nickel Co., Inc., New York, discussed different factors that influence corrosive attack on heat-resisting alloys which are exposed to hot sulfur-containing atmospheres. Alloy composition was given a high degree of importance because of its effect on fusion temperatures of the sulfide corrosion products and the mode of formation of these products at and beneath the metal surface.

Generally, the extent of attack is appreciably less severe under conditions which permit simultaneous formation of an oxide film. Sulfidation of pure nickel and high-nickel alloys induces pronounced embrittlement as a consequence of low-melting reaction products that are disposed principally in the grain boundaries.

Thermoplastic coatings.—A series of exceptionally heat-stable thermoplastic fluorochlorocarbons, commercially available as KEL-F, are highly resistant to a large number of chemicals, according to L. C. Rubin and W. O. Teeters, M. W. Kellogg Co., Jersey City.

The use of KEL-F diaphragms in Saunders-type valves has solved many operating and corrosion problems. Suitably designed KEL-F "O" rings and gaskets have solved gasket problems in some highly corrosive systems.

Application of the coatings by dispersion of finely divided KEL-F plastics in a volatile vehicle is being studied. Preliminary data on vapor permeability of films prepared from dispersion indicate the coating to be superior to most other plastic films tested, the authors said.

Performance of KEL-F coatings is dependent to a large extent on the molecular weight of the polymer. Molecular degradation of the polymer during the fusion operation and subsequent heat aging are influenced by various metals; in some cases excessive degradation has resulted.

Sulfide Corrosion

High-strength alloys are susceptible, N.A.C.E. hears

Walter Rose

GALVESTON, Tex.—Hydrogen sulfide corrosion of oil-well tubular goods and well-head equipment in sour-crude and gas wells is associated with alloys of high strength, members of the National Association of Corrosion Engineers were told here.

F. A. Prange, Phillips Petroleum Co., said cathodic field tests indicate that the maximum alloy hardness which should be used in embrittling conditions is Rockwell C-20.

C. N. Bowers and coauthors, of Gulf Research & Development Co., asserted that most steels with a mechanical hardness in or above the critical range represented by Rockwell Hardness C-24 to C-26 may be rendered susceptible to failure in hydrogen sulfide environment.

Tests, Bowers said, showed that failures occur because of stress-corrosion cracking. Embrittlement resulting from exposure to moist hydrogen sulfide is not a primary cause.

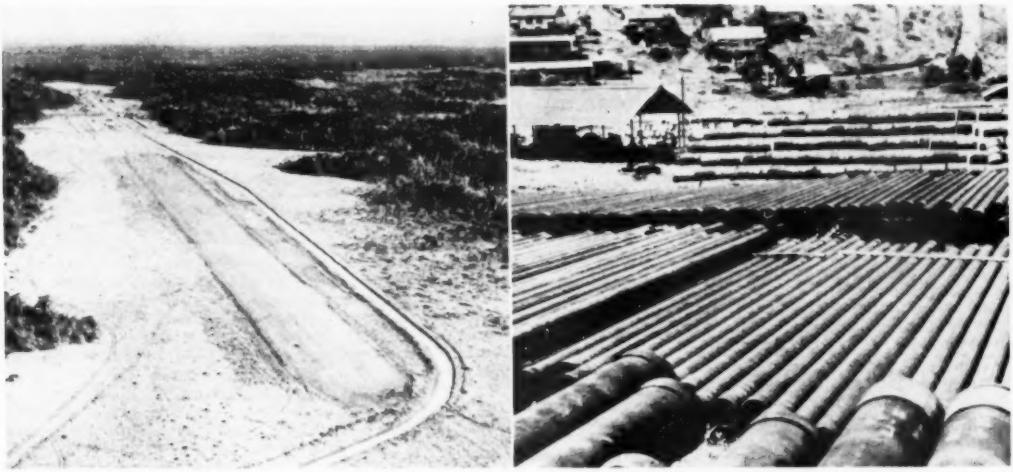
A laboratory study of factors related to the spontaneous cracking and embrittlement of steel alloys in sour-gas condensate wells was described by J. P. Fraeser, Shell Development Co. Factors included: (1) The composition and heat treatment of the alloy, (2) type and magnitude of stress, (3) composition of corrosive agents, and (4) pressure, temperature, and time of exposure conditions.

Study of corrosion rates and effectiveness of inhibitors under conditions where bottom-of-the-hole environmental factors are simulated was discussed by Walter Rogers and coauthors, of Gulf Oil Corp., through laboratory procedure. Mercaptans, they said, act as inhibitors, and pointed out that these compounds are sometimes naturally occurring.

Corrosion costs high.—A survey conducted by Humble Oil & Refining Co. showed that costs of corrosion in sour-crude wells ranged from $270 to $2,000 per well per year prior to initiation of remedial measures.

The survey revealed, according to J. A. Caldwell, that 44 per cent of the approximately 8,000 wells studied were "economically affected" by corrosion.

"Substantial reduction in the cost of corrosion has been effected in some cases by application of various remedial measures," Caldwell said.



JUNGLE ACTIVITY.—Airstrip, left, built by Australasian Petroleum. Virgin jungle had to be cleared before strip was built. Right: Pipe yard at Badilli, where casing is stored before moving to drill site.

ASIA

Jungle Drilling Program

Australasian Petroleum has drilled more than 54,000 ft. in seven wells in Papuan jungle of Southeast New Guinea

ONE of the most intensive sustained exploration programs being carried out abroad is in the Papuan jungle in southeastern New Guinea. Here Australasian Petroleum Co., Ltd., has drilled a total of more than 54,000 ft. in seven wells.

No commercial production has yet been discovered, but the work is being pushed forward despite the difficult jungle terrain.

The operating company is owned by Anglo-Iranian Oil Co., Ltd., and Standard-Vacuum Oil Co. with minority participation by Australian capital. The program began before the war, and was resumed in 1946.

Two wells drilling.—Wells currently under way are Hohoro 2 and Omati. The company has five rigs, two capable of depths in the 12,000-ft. range and three other lighter strings. Considerable difficulty has been experienced with a plastic mudstone formation that extends along the coastal region of Papua from Yule Island to the eastern edge of the delta region.

At a cost of about a half a million Australian pounds and 11 months of effort, Hohoro 2 has been taken to around 10,000 ft. During drilling, the second Hohoro test used 3,600 tons of mud chemicals, mainly barytes.

A total of 45 whites and 300 natives are employed at the well site, and 2,000 tons of materials, including rig equipment and housing, have been transported to the location.

Geophysical work.—Geophysical work is being continued elsewhere in the area. The three seismic parties now working between Romily Sound and the Bamu River involve a staff of 64 and a labor force of 650. Thirty-five launches are required, and the expenditure of explosives amounts to 45 tons a month.

Rainfall in this region exceeds 200 in. a year, and ranges on up to 300 in. Rivers provide the main avenues of transportation with a supplementary use of aircraft.

MIDDLE EAST

Next Move Up to Iran

The next move in the current effort to settle the Iranian oil dispute is up to the Iranian Government.

The British replies to questions raised by Iran on the settlement proposals of the International Bank for Reconstruction and Development have been communicated to the Iranian Government, and conferences were under way this week in Teheran.

Prime Minister Mossadegh met with the shah for 3 hours early this week, presumably to discuss the oil question. Earlier, the prime minister talked with Hector Prudhomme, World Bank official who had attended the previous week's conferences in London.

The only optimism over the prospects of an early agreement was among some Iranian officials in Teheran and not in London. British Government officials saw little hope that the Iranians will allow any acceptable degree of non-Iranian management of the industry.

AUSTRALIA

Exploration Work Continues

Exploration is continuing in scattered areas of eastern Australia in addition to the major effort which is being made on Western Australia's Northeast Cape by a Caltex-Ampol company.

The Australian Bureau of Mineral Resources has intensified its work in Southeast Victoria with ground and aerial surveys. Seismograph work has been undertaken with new equipment recently received from Sweden.

An announcement in Melbourne said Associated Australian Oilfields will soon be ready to start drilling its first well on a structure in the Roma, Queensland, area which was indicated by Commonwealth government geological surveys.

Refining in Russia

While it is technically advanced, weaknesses include lack of instruments, abuse of equipment, Winkler says

Dahl M. Duff

THE refining industry in the Soviet Union is in all probability still hampered by the common Russian tendency to overwork plant equipment to the point of abuse.

Dr. Joseph Winkler, Polish chemist and engineer who spent the war years working in the Russian petroleum industry, considers this to be a fundamental weakness in Soviet oil refining. Plant managers are under constant political pressure to achieve the utmost production, and the result is frequent breakdowns with consequent loss of running time.

Now associated with a chemical-byproducts company in New York, Dr. Winkler took refuge in Russia after the Germans overran his country. From 1941 to 1944 he was used in managerial and research capacities at several Russian oil centers. He came to this country in 1945 with a Polish supply mission, and walked out as an embassy technical attache 2 years later.

From his own experience in Russia and from subsequently following developments as closely as possible, Dr. Winkler is convinced the matter of downtime in the refineries provides a major problem. Mechanical shops in general are not adequate either in skilled labor or supplies to cope with the repair work required.

In Russian refineries the head of the laboratory occupies an unusually powerful position. Virtually all the plants have first-class products laboratories, and the standards laid down by the state for the particular operation must be rigidly met. An adverse report from the laboratory often can result in removal and sometimes jail for the plant manager.

Shortage of instruments.—Another deficiency in the Soviet refining industry is the lack of precision instruments. Automatic-control equipment is far less common than in the United States. Registering meters are of course used, but most control of flow, temperature, and pressure is manual. This adds to the problem of meeting specifications and operational safety.

On its upper level Russian technology is excellent. This top group, while not numerous, is made up of highly competent technical personnel. Below this level, however, is a vacuum which shows in a shortage of such classifications as skilled mechanics, welders, and unit operators.

Members of this group sometimes move up to the top technical level through the system of completely free education, even to a doctor's degree for promising students. More often for one reason or another they are dropped back into the great Russian reservoir of low-paid slave labor.

Varied equipment.—Russian refining is characterized by the fact that the plants cover almost the complete span of processing development from the most antiquated batch stills to modern catalytic cracking units. This arises out of the constant need for additional capacity and prevents the retirement of outdated equipment such as is the practice in this country. Whatever is running, regardless of its condition, usually is continued.

Prior to the mid-1930's, the Russians had in general the Borman German thermal cracking unit which gave poor performance. In 1934-35, Winkler-Koch units were received from the United States, and these were subsequently duplicated under the name Sovietskij Kraking. Distillation equipment is similar to the standard Foster-Wheeler atmospheric-vacuum unit and is known as Sovietskaja Trubtsehatka.

Dr. Winkler said the Russians are conservative at branching into new designs but are quite capable at duplication. They have undoubtedly built other Houdry fixed-bed units using as models the three received during the war, but it is questionable whether they have gone extensively into commercial movable-bed units or fluid catalytic cracking.

Leakage a problem.—In the average Russian refinery, leakage is a problem, due to inadequate maintenance and the tendency to operate in excess of optimum capacity. This leakage is a principal cause of fire. Refineries often have one or two major fires a year, and though fire fighting is being improved, these facilities are believed to be on the whole still far from satisfactory.

These various deficiencies in the Russian petroleum industry are balanced off by several important sources of strength in which respects it has somewhat of an advantage over its counterpart in the western world.

Dr. Winkler points out many Americans are prone to belittle the status of Russian technology. This is a mistake because the Russian petroleum industry does have at its command first-class, competent, and imaginative scientists. Furthermore, because of the importance of oil, these men can be mobilized at once on any particular project and taken from almost any other field of activity.

Great resources.—Russian industry in general, petroleum included, is backed up by tremendous undeveloped natural resources. From his own observation, Dr. Winkler believes geophysical prospecting is probably as advanced as it is in the United States. The many good untested prospects result in an oil-finding ratio which may be as much as twice as high as it is in the United States.

The Russian system of absolute governmental control contains a certain flexibility which allows a high priority for any undertaking which the state regards as desirable. Money, materials, and labor can be quickly shifted within the petroleum industry to whatever the government directs. Physical comfort of the labor force, which in the American industry is manifested in housing, recreation, and medical care, is not an important consideration.

In addition, the Russian scientist has available to him technical intelligence and literature which is carefully gathered throughout the world. The government sees that such information is placed at his disposal for the solution of any particular problem. His research is generally of an applied nature and closely directed, and he is under pressure to finish and find the answer in the time period allotted.

Production.—Dr. Winkler, whose position after the war required that he assist with the removal of certain synthetics plants from East Germany to Poland and the Soviet Union, does not believe total Russian synthetic production, both from Fischer-Tropsch and hydrogenation, is more than 2,000,000 to 3,000,000 tons at a maximum, or about 40,000 to 60,000 bbl. daily. Crude production in 1951, he estimates, ranged from 40,000,000 to 43,000,000 tons (800,000 to 860,000 bbl. daily).

Russian practice is to include the tonnage value of wet natural gas used outside the field, and this probably amounts to about 2,000,000 tons. Russian crude production is subject to heavy losses due to pipe-line leakage and the necessity of storing oil in open earthen reservoirs.

Fuel-Saving Device Claimed

Hungary, which hasn't done too well operating its expropriated oil industry, now claims development of a fuel-saving device which will cut gasoline consumption 15 to 40 per cent.

A report in a Hungarian trade-union newspaper said the attachment, patented by a Hungarian army captain, can be fitted to the carburetor

of any type of automobile. It was said to automatically reduce the gasoline supply when the load on the motor is reduced, when the brake is applied, or when running downhill.

A further refinement is a lamp on the dashboard. When less gasoline is being used, the light burns more brightly. When no saving whatsoever is being made, the lamp goes out altogether.

Hungary once produced 11,000 to 12,000 bbl. of oil daily. Difficulties under Communist control have curtailed output. Though little exact information is available, present production is believed to be not more than 9,000 bbl. daily.

British Raise Gasoline Tax

The already stiff price of gasoline in Britain is being boosted to the equivalent of nearly 50 cents per gallon.

The new British Government budget announced last week calls for an additional tax of about 8¾ cents on this already heavily taxed commodity. As a result, in the inner zones —closest to refineries and terminals —a British motorist will pay 4 shillings 2¾ pence per Imperial gallon, or 49.4 cents per U. S. gallon.

About 62 per cent of the total price will be the tax. The new tax increase of 7½ shillings also was applied to motor oil.

The additional tax was an avowed move by the government to curtail consumption and save dollar exchange. However, civilian gasoline consumption in Britain has already been deeply cut and commercial usage makes up an estimated 70 to 80 per cent of the total.

Meanwhile, economic difficulties have forced indefinite postponement of earlier plans to resume production of premium-grade motor fuel.

The government announced in the House of Commons that gasoline quality will continue to be limited to the single pool grade of 70-72 octane.

Britain is considering a proposal to require refiners to switch catalytic cracking units to straight crude distillation, to increase production of heavy fuel oil which is in short supply in the Eastern Hemisphere. Refiners object on grounds it would require uneconomic operation.

French Plan Deep Drilling

Soc. Nationale des Petroles d'Aquitaine is making plans for additional drilling to reach deep formations which have been discovered in Lacq field in southern France.

The company's 13,000-ft. test, drilled on an inside location, blew out under gas pressure of about 6,500 psi. and was brought under control after Myron Kinley, Houston wild-well expert, came from the United States. The gas showed considerable H.S.

Earlier, reports were that good-gravity oil at a rate of more than 100 bbl. an hour had been tested in the well from 11,440-11,506 ft. The original Lacq production was discovered in 1949, and there are now 17 producers making about 5,000 bbl. daily from depths around 2,200 ft.

A recent report from Paris said the Aquitaine company is studying the possibility of construction of two pipe lines to Bayonne and Bordeaux.

Lacq has become the principal source of crude oil in all French territory. It is the main result thus far from the government-supported French exploration program which is involving an expenditure of the equivalent of about $280,000,000 during the 10 years from 1946-56.

LATIN AMERICA

Venezuelan Expenditures

Three major operators alone will spend $270,000,000 this year; new concessions could raise investment appreciably

EXPENDITURES of the petroleum industry in Venezuela will be substantially greater in 1952 than they were last year.

Announcements of the three major operators—Creole Petroleum Corp., Mene Grande Oil Co., and Royal Dutch-Shell—show that their expenditures will be approximately $270,000,000 in 1952.

Between them, these three companies produce slightly more than 90 per cent of the 1,830,000 bbl. daily current Venezuelan oil output. Estimating expenditures for the remaining companies on a production basis indicates total outlay by the industry this year in Venezuela will be approximately $300,000,000.

However, expenditures of the 10 smaller companies in all probability aggregates more than the ratio of their share of the production. Viewed in this light, the $300,000,000 estimate would appear to be conservative.

Creole, leading Venezuelan company, is making investments this year of nearly $100,000,000. About $60,000,000 of this is going into development and production. Creole's 1952 outlay represents an increase of approximately one-third over the total spent last year.

Shell, second largest operating company, plans to spend the equivalent of 352,000,000 bolivars, or about $105,000,000, on expansion in Venezuela this year. Shell has disclosed that its 1952 budget provides for an investment of $42,000,000 in drilling and new equipment.

Besides intensifying exploratory work, Shell is carrying out a major enlargement of the Cardon refinery. Erection of a second crude still, enlargement of the first, and conversion of a redistillation unit to run crude will raise capacity from the present 83,000 to 170,000 bbl. daily and make Cardon the fourth largest operating refinery outside the United States.

Mene Grande expects to spend close to $70,000,000 in Venezuela during 1952. About $15,000,000 will be used in development drilling, $34,000,000 in all phases of exploration, and about $20,000,000 on pipe lines and other transportation facilities.

Production.—Latest available figures on crude production in Venezuela show that during the week ended February 25, output reached 1,832,600 bbl. daily. The previous week, production hit 1,830,400 bbl. daily. Both these figures represented new records on a weekly basis.

Creole's production, now slightly above 800,000 bbl. daily, including purchased royalty, is expected to rise about 5 per cent during the year, or to about 840,000 bbl. daily. Venezuelan production—stimulated by the heavy demand for low-gravity oils which are in short supply largely as a result of the Abadan shutdown—reached 1,811,700 bbl. daily in January. If the upward trend continues, total output is almost certain to exceed 1,900,000 bbl. daily by the end of the year.

New concessions.—One large unknown in assessing the industry outlay in Venezuela during the current year is the prospect that the government will grant new concessions for the first time since 1944. The government invited offers during the closing months of 1951, and reports are that the bids submitted aggregate as much as $150,000,000. Unusually high offers were made for the more attractive acreage near present production.

The question of making awards reportedly now rests at the highest government level, that is, the ruling junta. There is nothing to indicate when action will be taken. New concessions, if granted, could add as much as 50 per cent to the indicated industry expenditures in Venezuela this year.

Even without the small-scale boom which would result from exploration and development of new areas, industry activity in the country is definitely on the upgrade. All the indexes—production, rigs running, exploration parties in the field—point to a continued increased tempo of operations.

There are now approximately 110 rigs in operation in Venezuela, a gain of 20 during the last 15 months. Eighteen of these are on wildcat programs.

PAD's plans. — The foreign development program supported by the Petroleum Administration for Defense calls for the drilling of 1,424 wells in Venezuela during 1952. This compares to 1,216 wells drilled in the country in 1951 and only 673 in 1950. Thus, the 1952 outlook is for more than double the number of wells year before last.

There are indications, however, that the total of wells included in the PAD program for Venezuela may be short of actual performance of the industry. PAD in December said the 1,424 wells would permit a crude production of 1,744,000 bbl. daily during the year. Barring a completely unexpected downturn of activity, Venezuela is sure to exceed this figure which is only 39,000 bbl. daily above daily average output for 1951.

Seeks Return of Tankers

Gordon Duke, Southeastern Oil Co. president, has asked the Mexican Government to return several tankers which he sold in 1948 as a part of a deal to obtain drilling rights in the country.

Reports from Mexico City this week said that since the government has advised Duke it will not give the drilling contract, Duke in turn has notified the government that he wants the vessels back. Duke was said to have sold the tankers to Petroleos Mexicanos at a loss on the basis that he would receive a cost-plus drilling contract and the right to export some crude oil.

Mexican Discoveries Shallow

All but two of the six oil and gas fields discovered in Mexico during 1951 were at levels of less than 5,000 ft., it has been disclosed by geological descriptions of the fields released by Sen. Antonio J. Bermudez, director general of Petroleos Mexicanos, through his Washington information office.

The two exceptions were Jose Colomo field in Tabasco, brought in at 5,576 ft., and Trevino field in Tamaulipas, discovered at 6,730 ft.

Five new oil fields and one new gas field were discovered last year, the others being Rabon Grande and Concepion fields in southern Veracruz, Lomitas gas field in Tamaulipas, and Tamiahua field in the north zone of Veracruz.

The 1951 discoveries brought the total of new fields discovered since 1946 to 24, approximately one-third of all the commercially productive fields discovered in Mexico in the past half-century of oil development, Bermudez said.

Jose Colomo field is regarded as the most important in many years, with reserves already known to be more than a quarter-billion barrels, he reported.

The discovery well, 1 Jose Colomo, was drilled on an anticline found by reflection-seismograph exploration. Depth of the well was 5,576 ft. and the producing formation is the lower Amate sand of Miocene age. It was completed April 21 with an initial daily production of 1,195 bbl. of oil and half a million cubic feet of gas.

Bajo de Cara Work Continues

Mene Grande Oil Co. has not suspended oil operations and production in the Bajo de Cara area in eastern Venezuela because of the litigation now taking place over surface rights, according to Hoyt Sherman, president of the company.

In a statement in Caracas, Sherman explained that Mene Grande had negotiated surface rights in the area from private owners and that subsequently a third party had claimed title to the property. Mineral rights in Venezuela are owned by the government. Sherman pointed out that the outcome of the current litigation will not affect oil operations.

The area involved actually is East Soto field, about 10 km. north of West Nipa in the State of Anzoategui. Late in February, the high court of Barcelona, capital of Anzoategui, reversed a decision of a lower court and upheld the claim of parties other than those from which Mene Grande had obtained surface rights.

At the time, this decision was interpreted as requiring the company to halt operations until it could come to terms with the owners or file a suit for expropriation and pay compensation. However, later reports said the operations in the field would continue while the Venezuelan Government, as a party interested in the oil industry, was consulted.

Topping Plant on Stream

A new topping plant, with a capacity of 5,000 bbl. daily, has been placed on stream at La Dorada on the Magdalena River in Colombia.

The plant will be operated by Esso Colombiana, S. A., and will be charged with crude from the Velasquez concession of Texas Petroleum Co. Esso Colombiana is the marketing firm in Colombia which replaced Tropical Oil Co.

The plant will be operated initially at about 2,300 bbl. daily and will supply products to the local market. It will produce primarily tractor fuel and fuel oil.

Crude for the plant has been shipped upriver from Pto. Nino, the river terminal for Velasquez field, but around April 1 a 4 and 6-in. pipe line will be completed from Velasquez to La Dorada. Williams Brothers Corp. is now completing this 39-mile line.

Plans call for a pipe-line link between Cantimplora and Pto. Salgar which is across the river from La Dorada. A line from Salgar to Bogota is due to be placed in operation by the end of March, and the Cantimplora line would give pipe-line transportation from the Barrancabermeja refinery to the Colombian capital.

An existing products line now connects Cantimplora and Barrancabermeja. The 91-mile Cantimplora-Salgar line, to be built by the Colombian Government oil organization, has been authorized but it is reported steel not yet obtained.

AFRICA

Sahara Attracts Attention

The petroleum-producing possibilities of the northern Sahara Desert region are attracting increasing attention, according to reports from Algiers.

Several French companies have applied for exploration rights in this region, and plans now being made indicate an intensive investigation of southern Algeria. If this program materializes, it will be a further addition to the extensive work now being conducted with government financing throughout metropolitan France and its overseas territories.

The only production at present in Algeria is from Oued Gueterini field in the northern part of the country. There are three flowing and nine pumping wells producing a total of about 200 bbl. daily. A new well is reported to have been brought in recently with the considerably higher production of about 125 bbl. daily.

International Briefs

Final agreement for construction of a new 60,000-bbl. daily refinery near Fremantle has been signed by representatives of Anglo-Iranian Oil Co., Ltd., and the Western Australia government. The plant, to cost about 40,000,000 Australian pounds and to be completed in the next 3 or 4 years, will be located at Kwinama, Cockburn Sound. The agreement for construction of the plant will go before the state parliament this month for formal ratification.

Shell scientists working independently in Britain and the United States have found that the addition of small quantities of tricresyl phosphate to aviation gasoline increases the serviceability of piston engines by countering the effect of lead deposits. A report from London said that hundreds of tests of the development had been made, including more than 4,000 hours of successful flight testing.

PERSONALS

In New Job

Horner to head Sunray's new reservoir department

WILLIAM L. HORNER, chief production engineer of Sunray Oil Corp., has been named manager of the company's new reservoir-engineering and repressuring department.

The new department, working with the production and natural-gas sections of the company, will be responsible for instigating Sunray's reservoir-engineering and repressuring projects and will control operations in this field.

Horner became associated with Sunray early in 1950 as a result of the merger of Barnsdall Oil Co. into Sunray.

Widely known for his work in unitization and pressure maintenance, Horner is chairman of the engineering committee of the Scurry Area Canyon Reef Operating Committee, now negotiating a unitization agreement for repressuring reef fields in Scurry County, Texas.

The new department head is a 1928 geology graduate of the University of Pittsburgh. In 1934 he received a professional degree in petroleum engineering from the same university and in 1951 was awarded a professional degree in geological engineering.

Horner joined Forest Oil Corp. in 1932, specializing in water flooding and reservoir research. In 1936 he joined Core Laboratories, Inc., as a director and as vice president in charge of development of core analysis and reservoir engineering.

On January 1, 1943, he joined Barnsdall as manager of the secondary-recovery department, later becoming chief engineer.

Foster Morrell has resigned after 25 years with the U. S. Geological Survey and will open offices at Roswell, N. M., as a petroleum consultant specializing in work on federal and Indian lands, particularly in the Southwest. Morrell had been regional oil and gas supervisor for the southwestern region of the conservation division since 1945.

Sidney S. Galpin has been appointed an assistant superintendent in New York State Natural Gas Corp.'s Oakford storage district.

Walter E. Sistrunk, independent operator of Jackson, Miss., has been elected to fill the unexpired term of office as vice president of the Mississippi Geological Society. He replaces **F. T. Holden,** geologist for Carter Oil Co., who was transferred to Tulsa.

Henry N. Toler, chief geologist and manager of the production department of Southern Natural Gas Co., has resigned and will open offices as a consulting geologist in Jackson, Miss., where he has been located for many years. Toler has been active in the American Association of Petroleum Geologists and served as secretary-treasurer and a member of the executive committee of that organization during 1949 and 1950.

Donald G. Hitt, M.B.E., was scheduled to leave New York March 14 to take up a new assignment with Anglo-Iranian Oil Co., Ltd., in London. **John O'Hara,** who arrived in the United States a few weeks ago, will succeed Hitt as American representative in the company's project-engineering division. Hitt, who has been with Anglo-Iranian since 1946, has been in the United States 5 years. O'Hara joined Anglo-Iranian during the early days of the last war as a project engineer on some of the extensions to the Abadan refinery.

D. G. HITT

JOHN O'HARA

Joseph F. McCarthy has been appointed assistant superintendent of Humble Pipe Line Co.'s Southwest Texas division at Corpus Christi. **Francis W. Leary** and **William W. Brooks** have been appointed district superintendent and assistant district superintendent, respectively, of the company's Alice, Tex., district.

W. E. FERGUSON

William E. Ferguson has been elected vice president in charge of the production and storage department of Ohio Fuel Gas Co., Columbus, Ohio. **James A. Scanlon,** who has been treasurer, was elected vice president in charge of rates and regulations, and **John M. Rutherford** was elected new treasurer and will also continue as company secretary. Prior to his new appointment Ferguson was manager of the production and storage department.

John A. Cooper, geologist with National Drilling Co., has resigned and opened offices at Mount Vernon, Ill., as a consulting geologist.

R. L. KEYES

R. L. Keyes has been elected president and a director of Arabian American Oil Co. succeeding **W. F. Moore,** whose resignation for reasons of health was announced in January. At that time, **F. A. Davies,** formerly executive vice president, was elected board chairman and made chief executive officer of the firm. Keyes, who was formerly assistant general manager of The Texas Co.'s producing department at Houston, will leave soon for Dhahran, Saudi Arabia where both he and the chairman of the board will make their headquarters.

Coleman L. Lofton, assistant geologist for Tide Water Associated Oil Co. at Houston, has been transferred to Corpus Christi, Tex. **Clarence J. Montgomery, Jr.,** rejoined Tide Water at Houston as chief civil engineer after closing his offices as a consulting engineer.

J. M. Rosborough has been named assistant division superintendent in the light-oils-finishing department of Lago Oil & Transport Co., Ltd., Aruba. **H. V. Massey** was named maintenance foreman in the department replacing **T. H. Harrod,** who recently was made process foreman. Rosborough joined Standard Oil Co. (Ind.) in 1929 and transferred to Aruba in 1930 as a chemist. Massey has been with the firm since 1929.

PERSONALS

James C. Reid, vice president and operating manager of Southern Union Gas Co., Dallas, has been elected to

JAMES C. REID

H. N. OLDHAM

the newly created position of executive vice president. **H. N. Oldham,** assistant operating manager, was made vice president and operating manager. Reid has been with the firm for 16 years, moving to Dallas in 1937 to head the engineering department. Oldham is an engineering graduate of the University of Arkansas, and has been with Southern Union for 17 years.

H. A. Sellin has been promoted to regional exploration geologist and transferred to Magnolia Petroleum Co.'s general offices in Dallas replacing **C. Ivan Alexander,** who has been made supervisor of the exploration research division. **W. Lloyd Haseltine,** district geologist at Wichita Falls, has been transferred to Mount Vernon, Ill. **John C. Freeman** has been promoted to district geologist at Wichita Falls. In the producing division the following changes have been made: **Lawrence M. Green,** formerly assistant foreman at Falfurrias, Tex., has been promoted to production foreman in the Vanderbilt district. **Charles A. Miller,** petroleum engineering assistant in the Kermit district, has been made assistant foreman in the newly created Pegasus district near Midland, Tex. **Marion W. Lovelace,** production pumper in the Brownfield district, has been promoted to assistant foreman in the Pegasus district. **Don B. Chism,** gang pusher in the Lake Charles producing district, has been made assistant foreman of the same district.

W. S. Stovall has been transferred from Great Bend, Kans., to Tulsa to head Carter Oil Co.'s petroleum-engineering section. **W. C. Butler** has been transferred from Carmi, Ill., to Great Bend as district engineer. Other Carter changes include: **S. G. Branyan,** transferred from Magnolia, Ark., to Seminole, Okla., as district engineer; **Howard C. Kauffman,** transferred from Vicksburg, Miss., to Magnolia, Ark., as district engineer; **H. H. Goerner,** petroleum engineer at Magnolia, Ark., transferred to Vicksburg as district engineer; **R. B. Chapman,** assistant division engineer of the central division at Oklahoma City, named acting division engineer; **H. E. Allen,** transferred from Wilson, Okla., to Oklahoma City as acting assistant division engineer; **J. L. Barthel,** transferred from Purcell, Okla., to Wilson as acting district engineer, and **J. S. Bottler,** transferred from Tulsa to Shreveport as a member of the southern division engineering staff.

Raymond A. Metzke has been promoted from operating manager for United Gas Co. at Beaumont, to manager of the company's Southwest Texas distribution division with headquarters at New Braunfels.

S. W. Day, vice president of Interstate Oil Pipe Line Co., Shreveport, has retired. Day began his career in 1905 as a pipe-line laborer for an affiliate of Standard Oil Co. (N. J.). When Interstate acquired Standard Oil Co. of Louisiana in 1945, Day was elected vice president and director and continued in that capacity until he retired.

Edward J. Boos has resigned as district head of exploration for Sohio Petroleum Co. at Casper, Wyo., to join **Emmett E. Schieck,** consulting geologist with offices in Casper. Schieck, formerly chief geologist with Morton Oil Co., became a consultant about a year ago.

Leroy D. Stinebower, formerly with the State Department, has joined Standard Oil Co. (N. J.) as assistant to the treasurer.

A. W. Andrews has been named operating superintendent at the East St. Louis refinery of Socony-Vacuum Oil Co., Inc. **R. S. F. Grieve,** former process engineer, was promoted to assistant operating superintendent succeeding Andrews.

S. M. Vauclain, geologist for Sun Oil Co., has been transferred from Jackson, Miss., to the Philadelphia office. Other geologists transferred by the company include: **Emil Monsour,** from San Antonio, Tex., to Jackson replacing Vauclain; **J. R. Moyer,** from Dallas to San Antonio replacing Monsour; **D. H. Cardwell,** from San Angelo, Tex., to Dallas; **George R. Washburn,** from Roswell, N. M., to Dallas; **Walter L. Erwin,** from Truth or Consequences, N. M., to Abilene, Tex.; **James J. Tucker,** from Corpus Christi, Tex., to Dallas; and **Forrest W. Bell,** from Delhi, La., to Shreveport.

James R. Willcockson has been named field seismograph supervisor in the central-division office of Stanolind Oil & Gas Co. at Oklahoma City. He has been with the firm since 1947.

M. H. Arveson, technical director of Indoil Chemical Co., a subsidiary of Standard Oil Co. (Ind.), has been elected to a 4-year term as a director-at-large of the American Chemical Society.

C. A. Johnson, chairman of the board of Socal Refining Co., Los Angeles, has been reelected president of the Independent Refiners Association of California. **B. E. Devere,** of Pathfinder Petroleum Co., was elected vice president at the recent annual meeting; **N. D. Taylor,** of Hancock Oil Co., was renamed secretary-treasurer, and **D. B. O'Neill** was reelected vice president and general manager.

LESLIE H. TRUE

Leslie H. True has been elected president of Magnolia Pipe Line Co. at Dallas. True's 30-year career with the firm started in his high school days when he worked summer vacations. He has moved up the ladder from pipe liner, time keeper, gager, pipeline scout, district superintendent, manager of pipe lines, vice president, and now to president. **Don R. Ford,** formerly assistant manager of pipe lines and a board member, has been

DON R. FORD

A. T. GLOVER

named vice president. He has been with the firm for 25 years starting as a pipe liner. **A. T. Glover,** general superintendent for the past 10 years, has been appointed a member of the board of directors. He has been in the Dallas office since 1942. **Earl A. Brown,** general counsel of Magnolia Petroleum Co., was named vice president and a member of the board of directors.

Barton W. Ratliff, production engineer for Skelly Oil Co., has been transferred from Velma, Okla., to

PERSONALS

Hobbs, N. M. **Chuck Lukeheart,** engineer trainee at Carthage, Tex., has been transferred to Hobbs as engineer.

Robert W. Frensley, formerly geologist with Continental Oil Co. at Wichita, Kans., has become a partner in the geological firm Landrum & Frensley at Ardmore, Okla.

H. R. WEITZEL

H. R. Weitzel has been named superintendent of natural-gas compressor stations operated by Manufacturers Light & Heat Co. and associated Pittsburgh Group gas companies in the Columbia Gas System. He succeeds **M. L. Cowden,** who has retired after 35 years. Weitzel, who joined the firm in 1937, served as a senior civil engineer until entering the gas-engineering department in 1946.

S. A. Taylor, formerly with Panhandle Eastern Pipe Line Co., has joined Trunkline Gas Co. at Houston as vice president.

J. E. Johnson has been appointed purchasing agent for Tide Water Associated Oil Co., and **G. W. Morris** and **D. L. Ratliff** were appointed assistant purchasing agents.

Walter F. Tucker, formerly with Ray-Harris Drilling Co., has become a partner in Tucker Drilling Co. at San Angelo, Tex.

B. R. Scharbarum, of Carl B. King Drilling Co., Midland, Tex., has been elected chairman of the southwestern district of the American Petroleum Institute's Division of Production. Vice chairman elected, and the areas they represent are: **J. W. Roche,** of Shell Oil Co., North Texas; **R. B. Chesney,** Sunray Oil Corp., Arkansas and North Louisiana; **J. A. Williams, Jr.,** The Texas Co., East Texas; **S. C. Oliphant,** Stanolind Oil & Gas Co., Texas Gulf Coast; **Louis Davis,** Atlantic Refining Co., Central Texas; **Roual Dunn,** Phillips Petroleum Co., New Mexico; **Roy E. Carter,** Carter Foundation Production Co., West Texas; **E. N. Van Duzee,** Shell Oil Co., South Louisiana; **J. B. Jones,** Halliburton Oil Well Cementing Co., Southwest Texas; and **W. W. Ramseur,** Gulf Refining Co., Alabama and Mississippi. **Ray Elner,** of Kobe, Inc., was elected secretary-treasurer, and **Olin G. Bell,** of Humble Oil & Refining Co., was elected chairman of the advisory committee.

Charles R. Wilcox, formerly geologist with **Walter Duncan** at Mount Vernon, Ill., has opened offices at Sidney, Mont., as a consultant for the Williston basin.

S. C. Yingling, independent producer at Evansville, Ind., has opened a branch office at Ada, Okla., with **Jim Ray** in charge.

Mearl Barnhart, formerly with Phillips Petroleum Co., has joined Stanford Petroleum Corp. at Evansville, Ind., as field superintendent for Indiana and Kentucky.

W. W. Woodward has been appointed district geologist in charge of Shell Oil Co.'s new Salt Lake City office. The new district will be responsible for the company's exploration activities in northeastern Utah. Woodward, who was formerly located in California and Nevada, will be temporarily headquartered at Grand Junction, Colo., until the new office is officially opened.

Norman C. Penfold, supervisor of automotive and engine fuels and lubricants research, has been named an associate director of Southwest Research Institute.

R. C. Harris and **Terry Mason,** both formerly with Atlantic Refining Co. at Maracaibo, Venezuela, have joined Union Oil Co. and will be stationed at San Jose, Costa Rica. Harris has been appointed manager of foreign operations for Union's exploration department and will be in charge of exploration work getting under way in Costa Rica.

Norman P. Rousselot has been named western division vice president of Seaboard Oil Co., succeeding **C. P. Watson** who resigned to become an oil consultant.

E. S. Marie, district geologist for American Republics Corp., and **Ed Brown,** geologist, have been transferred from San Antonio to Corpus Christi as a result of the firm's office move.

Ray Thompson, formerly with British American Oil Co., Ltd., has joined Hiawatha Oil & Gas Co., as division exploration manager and will be in charge of the firm's newly created office at Denver. **C. L. Severy,** formerly with The California Co., will be division geologist in the new office.

Charles D. McMurray, formerly geologist for Gulf Oil Corp. at Houston, has joined the geological staff of **Claude B. Hammill,** Houston, independent operator.

R. E. McMillen, division petroleum engineer at Houston for Ohio Oil Co., has been transferred to Findlay, Ohio, as assistant to the production superintendent. **L. H. Shearer,** petroleum engineer in the Houston office, replaces McMillen.

DEATHS

George W. Fox, 83, one of the pioneer rig builders in the Pennsylvania-West Virginia area, died recently in Mount Morris, Pa. He built the first oil derrick for old McDonald field in southwestern Pennsylvania.

Norman L. Dorn, 62, vice president of Lane-Wells Co., died recently in Long Beach, Calif. He had been connected with the petroleum industry for more than 30 years.

William de Witt Crampton, 61, one-time Paris manager of Bedford Petroleum Co. and vice president of Standard Francaise des Petroles, died in Washington, D. C., March 7. During the war he was transportation adviser and later director of the foreign supply and distribution division of the Petroleum Administration for War.

W. McKinley Harris, 50, Oklahoma City oil man, died March 6 at Midland, Tex.

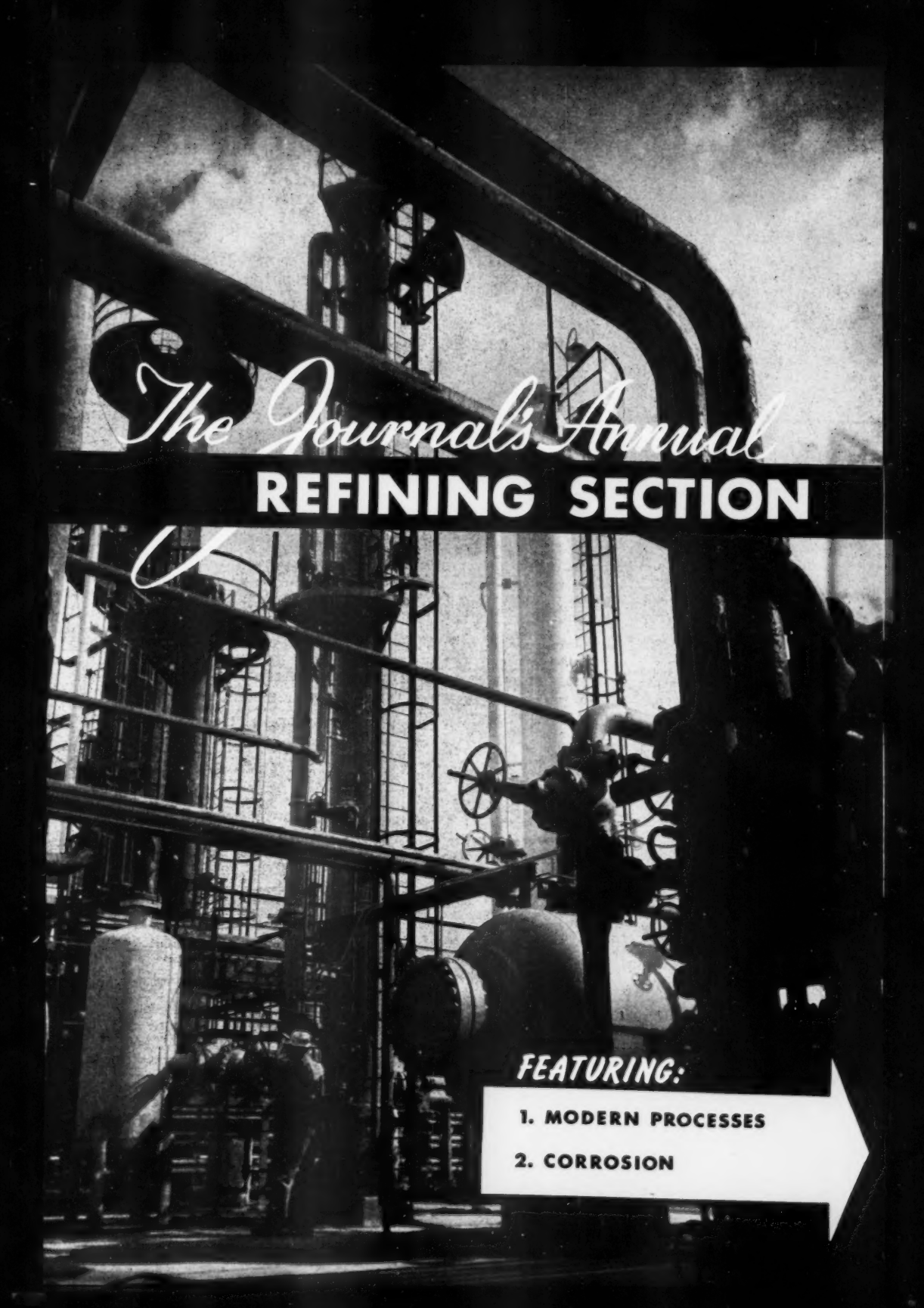
Walton Forstall, 82, retired vice president of Philadelphia Gas Works Co., died recently in Pittsburgh. Forstall joined the gas works in 1898 and remained with the firm until his retirement in 1936.

Charles F. Snyder, 66, of Fisk Brothers Oil Co., died recently at Elizabeth, N. J.

David M. Miller, 42, district geologist with Union Producing Co. at Beeville, Tex., died March 8 at San Antonio, Tex.

Frank D. Howell, division superintendent for Dominion Natural Gas Co., died in Brantford, Ont., March 6. He was a past president of the Canadian Gas Association and a member of the technical section of the American Gas Association.

T. J. Gensler, 66, retired Humble Pipe Line Co. engineer, died recently in Kilgore, Tex.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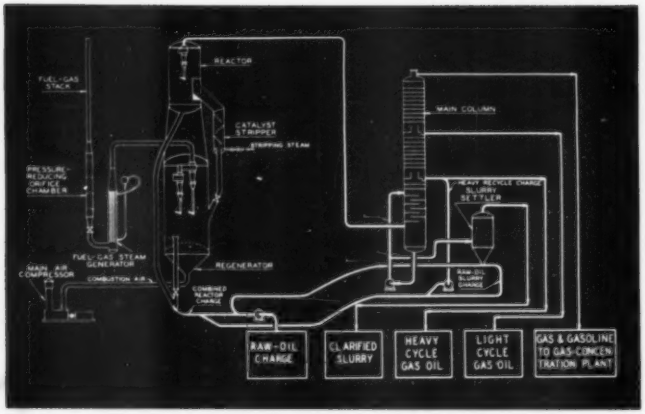


F.C.C.—U.O.P. Process

This diagram shows flow arrangement of a Universal Oil Products Co. type fluid catalytic cracking unit. The process is adaptable to production of either aviation gasoline, high-grade motor gasoline or raw materials for production of chemicals and synthetic rubber.

U.O.P.-type cat cracking units are designed in capacities ranging upward from 1,500 bbl. per day. Units of this type can be built and operated at costs comparing favorably with the cost of thermal cracking units of comparable capacity.

The process is flexible as to charging stocks and products. Kerosine, light or heavy gas oil, and some types of reduced crude oil may be successfully cracked by the fluid catalytic process. The gasoline produced is of a different character from that obtained by thermal cracking.

The latest-type U.O.P. unit operates with either natural or synthetic catalyst. Experience has shown that the catalyst makeup rate for replacement of losses and maintenance of activity in a number of commercial units is as low as 0.2 to 0.3 lb. of catalyst per barrel of fresh charge stock.

Principal modifications in the new improved unit as compared to the earlier design are:

1. In the small-size units reactor and regenerator have been combined in a single-tower erected as a self-supported column eliminating heavy structure required in the earlier units.

2. The large regenerator riser has been eliminated and regenerator standpipe considerably shortened. There has been a general reduction and simplification of small piping.

3. The stripper has been modified to reduce entrained hydrocarbons in the catalyst passing into regenerator.

4. Air supplied for combustion passes through the regenerator countercurrent to the catalyst. This permits multistage stripping and more complete utilization of oxygen.

The process is adaptable to the needs of large and small refiners. For those refiners engaged in petrochemical manufacture it is suited for production of base materials.

F.C.C.—Orthoflow

Relatively heavy hydrocarbon oils may be converted to high-grade lighter products by the Orthoflow-type catalytic cracking process, a development of M. W. Kellogg Co. Primarily the process is designed for use with "synthetic" catalyst consisting principally of silica and alumina. Cracking reaction promoted by the catalyst is at much lower pressure than encountered in thermal cracking; however, temperature is about the same.

Principal elements of the Orthoflow unit are reaction and regeneration vessels. These two vessels are combined, one above the other, in a single unit known as the Orthoflow converter. The reactor is located in the upper section of the converter with the regenerator occupying the lower position. A portion of the reactor vessel is employed as a catalyst stripping section.

Standpipes, through which oil charging stock, plus steam and catalysts are fed to the reactor, and the catalyst return from reactor via stripper to regenerator, are positioned inside the converter.

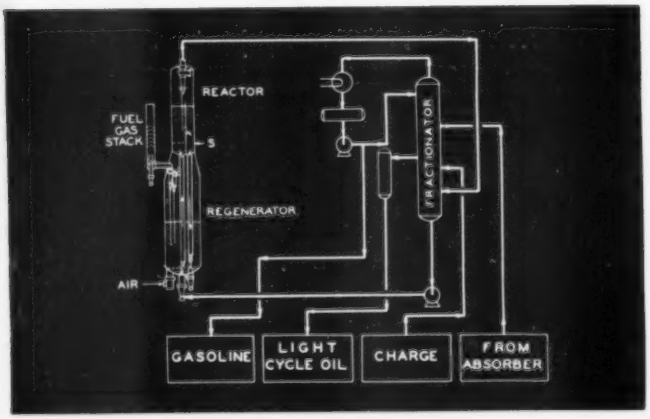
Catalyst and oil introduced into the carrier line to reactor passes through a "needle type" valve. Hot catalyst from the bottom of regenerator is drawn into carrier line by pressure drop caused by high-velocity oil passing through valve. Control of valves is automatic but valves are so located that they may be operated manually when desired.

Circulation rate of catalyst through the system is controlled on the regenerated-catalyst side of the circuit thus regulating temperature in the reactor.

Catalyst from regenerator to reactor supplies heat necessary to bring the oil feed to vaporization temperature, vaporize oil, and to offset heat of reaction.

Typical products obtained from an Orthoflow unit charging 30° A.P.I., West Kansas crude oils are:

- 22% F. e.p., debutanized gasoline.
- 325–450° F. naphtha.
- 29.1° A.P.I. light gas oil.
- 27° A.P.I. heavy gas oil.
- 23° A.P.I. decanted oil (fuel oil).
- Liquid propane and butane.
- Fuel gas.



Houdriflow

Either motor-gasoline or aviation-gasoline base stock, various light hydrocarbons, plus tractor and distillate fuels are produced by the Houdriflow type of catalytic cracking.

Potential charge stocks for Houdriflow operations include the full range from kerosine through vacuum gas oils and may include certain reduced crudes having low carbon content. By employing synthetic catalyst along with corrosion-resisting equipment at critical points, high-sulfur stocks may also be processed. Normally, the charge is preheated to such a degree that it is introduced in a mixed phase through a distributing nozzle located centrally within an annular curtain of catalyst at the top of the reactor. However, with appropriate design for balancing heat generation and absorption, total liquid or vapor charge streams may be processed.

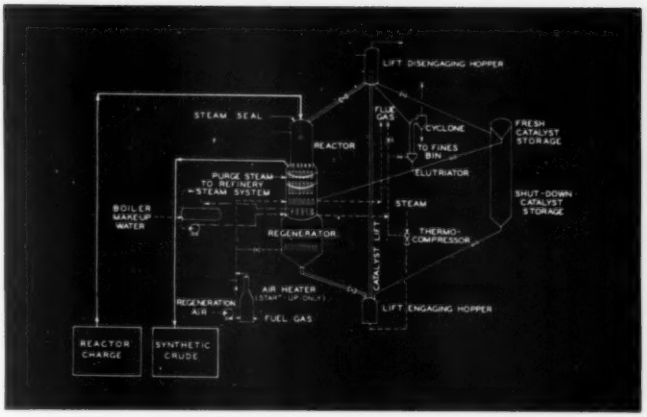
The vapor disengaging section is a combination of cup and transverse channel design. Vapors collected in the channels discharge into the annular plenum chamber formed by the swaged outer shell at the bottom of the reactor and a continuation of the straight portion of the reactor shell.

Flue gas for the lift is supplied by a thermocompressor which takes gas from the lower zone of the kiln at 2 psig. and compresses it to about 5 psig., using steam as the motive fluid. Therefore, it is not necessary to compress all of the regeneration air to the higher pressure needed for lift operation and a single-stage blower discharging at 4 to 5 psig. may be used.

Kiln pressure-drop relationships are set to take advantage of the reduced regeneration air pressure. The highest kiln pressure exists at the inlet to the lower burning zone while the top of the kiln is at essentially atmospheric pressure, permitting bypassing and depressuring of the reactor.

The accompanying diagram shows the flow scheme for the latest type Houdriflow cat cracking unit. One installation, now operating, incorporates into a single structure, four units of this type.

Houdry Process Corp. is licensor for this process.



Thermofor Cracking

The Thermofor type of catalytic cracking produces high-quality gasolines by conversion of heavier hydrocarbons.

This process is a simplified version of an earlier one, developed by Socony-Vacuum Oil Co., Inc.

There are three major differences which distinguish this later process from the earlier version. These differences are:

1. The air-lift unit, which employs a pneumatic transportation system for moving the catalyst from the base of regenerator to top of reactor.

2. The reactor is superimposed over the regenerator and has only one catalyst level; that is, the level in the separator surge hopper.

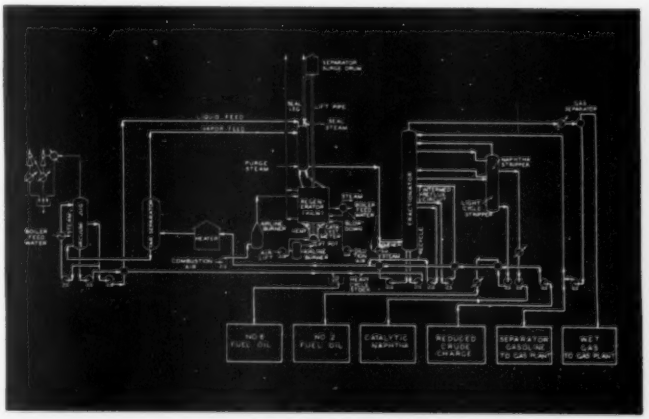
3. Catalyst-to-oil ratio has been moderately increased in the newer units, with the result that the carbon concentration on the spent catalyst has been reduced sufficiently so that a simplified regenerator, having only one air inlet and two flue-gas outlets, has resulted. Operation of this regenerator is far simpler than that of the earlier-type T.C.C. unit kilns, since it is necessary to remove heat by cooling coils at only one level. As a result the newer unit can, if desirable, maintain even higher catalyst activity than the earlier units.

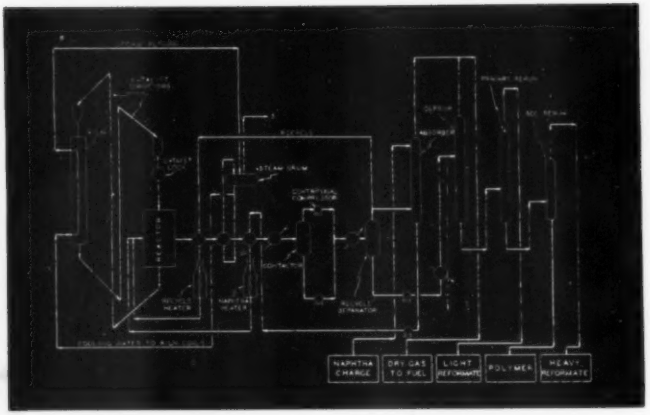
Most of the air-lift T.C.C. units are equipped to charge unvaporizable gas oils and consequently these units will handle all of the gas-oil components in crude oils, ranging from heating oil to asphalt.

Package units having total charge capacities below 6,000 bbl. per day employ the same moving-bed principles and the same air lift for catalyst, as used for larger units.

The packaged units, developed to meet the needs of smaller refiners, are in line with investment costs of the larger plants on barrels daily capacity rating. Field installation costs on the packaged plants are low because of erection methods and degree of prefabrication carried out on vessels and other equipment.

The Thermofor catalytic cracking process is licensed by Socony-Vacuum Oil Co., Inc.





Thermofor Reforming

Thermofor catalytic reforming is carried out with separate regenerator and reactor. Employing the moving catalyst-bed technique, the process operates for conversion of naphtha stocks. Conversion reactions include isomerization, cyclization, dehydrogenation, desulfurization, and hydrocracking. Product is a high-octane reformate rich in aromatics.

Many of the features incorporated in Socony-Vacuum's T.C.C. unit are included in this reforming process which is known as T.C.R. The process employs a bead catalyst developed jointly by Socony-Vacuum and Standard Oil Co. (Ohio). This catalyst is cogelled chromium-aluminia, harder than the silica-aluminia catalyst used in cracking. Catalyst-to-oil ratios average around one-tenth those of the newer T.C.C. processes.

In the T.C.R. units now designed either the bucket elevator or the newly designed air lift may be used to convey catalyst.

Reactor pressures for T.C.R. operations are relatively low, in the range of 100 to 200 psi. At 100 psig. reactor pressure, light medium naphthas (150°-250° F.) yield up to 10 per cent benzene, 20 per cent toluene, and 8 per cent C_8 aromatics. Prefractionation of naphtha feeds for selective aromatics production gives higher yields.

The aromatization promoted by the catalyst also makes it suitable for production of aviation blending stock. For example, a 208°-281° F. West Texas naphtha yielded 44.7 per cent of aviation-base stock with calculated blending values of 96 F-3 and 173 F-4 with 4.6 cc. TEL.

At reforming pressures of 100-175 psig. sulfur reduction ranges from 86 to 97 per cent for various naphthas. Pilot-plant tests, on a 50-bbl. per day unit, charging straightrun stock plus coker-gasoline feed from California crude oils, show substantial sulfur reduction. In these tests, feed-stock sulfur was 0.56 per cent with the reformate running to 0.036 weight per cent sulfur.

This catalytic reforming process is a Socony-Vacuum Oil Co., Inc., development.

Reforming—Perco Process

Desulfurizing and catalytically reforming cracked and straightrun naphthas, gasolines, or blends are accomplished via the Cycloversion process. Normal benefits derived from catalytic desulfurization are obtained along with an appreciable increase in clear octane rating. This is effected by some additional mild cracking or reforming as evidenced by the presence of fixed gases in the reactor effluent stream. Fixed gas losses are relatively low and gasoline yields are high, particularly in view of the C_3 and C_4 components recoverable as poly feed.

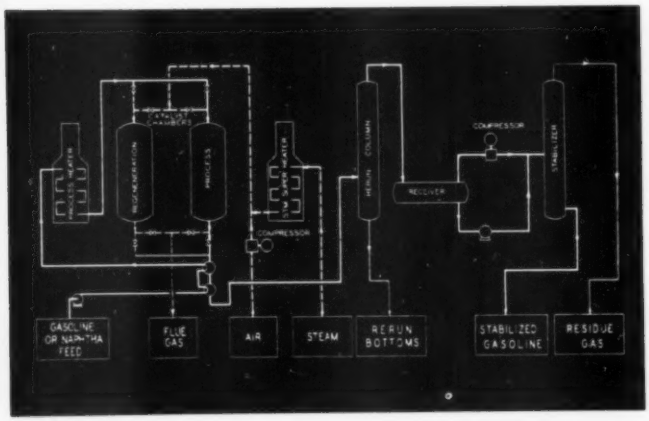
Normal operating conditions include chamber pressures from 50 to 100 psig., top-bed chamber temperatures of about 1,000° F., with processing cycles running to 24 hours or more.

Only a small deposition of carbonaceous material occurs during normal process operation as compared to conventional catalytic cracking. This low carbon deposition on the catalyst permits operation on relatively long process cycles and low-cost regeneration of the catalyst. Regeneration is carried out with a previously determined quantity of superheated air-steam mixture.

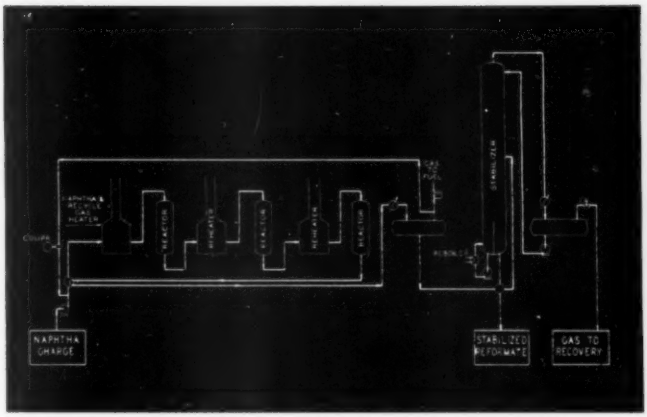
The process may be operated either at catalytic reforming or catalytic desulfurizing conditions. The unit is sufficiently flexible to enable refiners to conduct a wide variety of operations on selected fractions or on total refinery gasoline, as may be desired or dictated by economics and finished-product sales. Flexibility of operation will likewise enable the refiner to meet product specifications with optimum tetraethyl lead costs, by varying conditions at any time to handle the preferred stock or stocks. Cycloversion reforming is not only applicable to stocks having moderately high total sulfur but also to those stocks having relatively low total sulfur content.

Results obtained in processing various types of stock show appreciable increases in "jump" octanes, or the spread between A.S.T.M. and research values.

This process is licensed by Perco Division, Phillips Petroleum Co.



Reforming—Atlantic Process



Atlantic Refining Co.'s reforming process utilizes platinum as the active catalytic agent. Reactor-cases are employed to hold fixed beds of the pelleted form catalyst.

Charge stocks may include various naphthas and natural gasolines. Sulfur or normal water concentrations in the feed will not contaminate the catalyst. The undesirable sulfur compounds in the feed are almost completely removed with excess gas, as hydrogen sulfide.

Separator gas, composed normally of 97 to 98 per cent hydrogen, is compressed and recycled with fresh naphtha charge in the ratio of 10 volumes of hydrogen to 1 volume of hydrocarbon vapor. Excess hydrogen plus small amounts of methane, ethane, and in some cases hydrogen sulfide, is withdrawn from the system as fuel.

Regeneration takes place at process pressure, expediting turnaround. The circulating stream comprises less than 1 per cent of oxygen in an inert gas. Frequency of regeneration will be governed by the severity of operation which determines rate of coke deposition.

For the synthesis of specific aromatic compounds, such as benzene, toulene, or xylenes, special prefractionation of charge stock may be desirable to obtain selective cuts rich in naphthenes or molecular weights corresponding to the desired aromatics product.

With normal operating conditions required for reforming naphtha to motor gasoline, the process is continuous and nonregenerative and shows a high octane relationship in reformate. Liquid reformate is stripped of the propane and butanes in a single stabilizing column.

A balance of catalyst properties and operating conditions has been achieved in the process to yield an optimum combination of the desired isomerization and dehydrogenation reactions while minimizing undesired cracking reactions.

The process provides the flexibility for severe catalytic reforming without requiring excess capacity demanded in regular cyclic regeneration.

Fluid Hydroforming

Fluid hydroforming is a catalytic process for upgrading various naphtha stocks and for production of aromatics. The fluidized technique is utilized allowing continuous regeneration of catalyst. This process is the joint result of efforts of M. W. Kellogg Co., Standard Oil Co. (Ind.), and Standard Oil Development Co.

Features of the earlier hydroforming process were combined with those of current catalytic crackers in developing fluid hydroforming. This newer process incorporates two principal improvements over the older hydroforming unit. These are provision of isothermal conditions in the reactor as contrasted to original adiabatic hydroforming, and increased flexibility and uniformity of operation afforded by continuous catalyst regeneration.

The principal reaction in hydroforming, which is essentially a dehydrogenation - aromatization process normally using a molybdena-alumina catalyst, is the synthesis of aromatics. The process is conducted in the presence of gases rich in hydrogen, which are derived from the process itself.

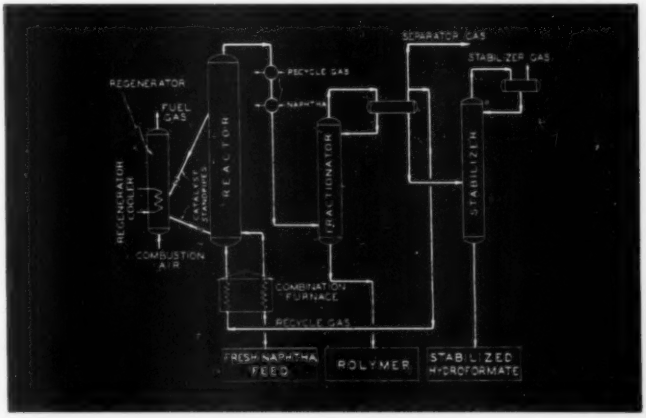
In addition to dehydrogenation of C_6 ring naphthenes to aromatics—other upgrading reactions occur. These are isomerization of C_5 ring naphthenes to C_6 ring naphthenes followed by dehydrogenation to aromatics, dehydrocyclization of paraffins to aromatics, isomerization of paraffins, hydrocracking, and desulfurization.

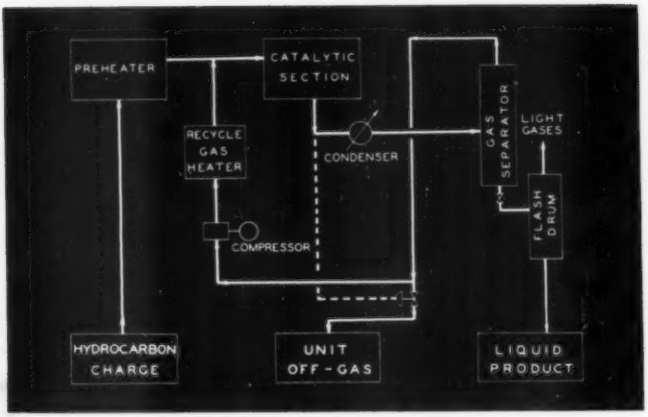
Feed stocks hanging from C_5 cuts (for benzene production) to kerosine can be employed if desired. Virgin heavy naphthas, kerosine, and high-sulfur cracked naphthas may be upgraded by the process.

Hydroforming reactions take place in the internally insulated reactor at about 200 psig. and around 950° F.

The regenerator in the process is about one-tenth the capacity of one serving a fluid catalytic cracker of comparable reactor capacity.

Spent catalyst from the reactor is removed through a standpipe and is lifted to the regenerator by suspension in compressed regeneration air. Catalyst stack loss from the regenerator after cyclone separation is below fresh catalyst addition needed to maintain desired activity.





Houdriforming

The Houdriforming process is applicable to production of maximum yields of benzene, toluene, and xylene from specific hydrocarbon fractions. Production of high yields of high-octane gasolines from straightrun naphthas is also possible. The isomerization function of the catalyst in addition to the dehydrogenation function permits reforming of low-octane naphthas to high yields of product of very high octane number.

Ordinarily the process is nonregenerative for the production of aromatics from a single wide-cut charge stock. However, for most severe conditions on unusually wide boiling-range charge, a catalyst deposit may accumulate slowly and the ability of the catalyst to be regenerated provides maximum flexibility. Thus a nonblocked-out operation can be employed for the simultaneous production of benzene, toluene, and xylenes. The catalyst employed in Houdriforming is highly selective and promotes little hydrocracking.

Upgrading of motor gasoline by Houdriforming is accomplished by five reactions: (1) conversion of six-membered ring naphthenes to aromatics, (2) dehydroisomerization of alkyl cyclopentanes to aromatics, (3) isomerization of straight chain or slightly branched paraffins to highly branched paraffins, (4) dehydrocyclization of paraffin to aromatics, and (5) desulfurization of naphtha which improves the lead response. The isomerization function of the catalyst for converting low-octane paraffins to high-octane branched chain paraffins is of importance in attaining the high yield of high-octane reformate.

Conversion of naphthenes to aromatics improves the octane rating only in the case of higher-boiling naphthenes. In employing Houdriforming for motor gasoline production it is, therefore, desirable to use only feed stocks which have been fractionated to include the maximum amount of naphthenes in a boiling range in which octane improvements can be obtained.

Houdry Process Corp. is developer and licensor of the process.

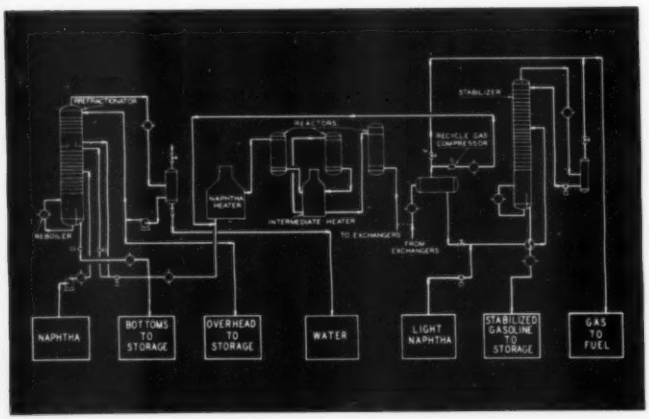
Platforming

Platforming is a catalytic process for upgrading motor fuel and synthesizing aromatics.

In the flow arrangement for motor-fuel operation, shown here, total feed is charged to a prefractionator, where the desired amount of light ends is removed overhead and a small amount of heavy ends is taken off as bottoms. The reactor charge, withdrawn as a side cut, is heated in combination with recycle gas. The combined streams pass through a series of reactors.

Effluent from the last reactor, after cooling, passes to a separator. Part of the hydrogen-rich separator gas is recycled through a heater to the reactors; the remainder leaves net make. Separator liquid flows to a stabilizer, the bottoms from which are finished gasoline or blending component.

Arrangement of the reactor section for aromatics is similar to that shown in the accompanying diagram. However, in most cases a two-tower prefractionating system would be utilized and, of course, facilities to separate aromatics in desired purity from the stabilizer bottoms are required.



Straightrun gasoline fractions in the 100°-400° F. boiling range are suitable charge stocks. Similar fractions of many cracked gasolines may be added to the straightrun charge, in which event the product will be essentially the same as that derived from straightrun naphtha alone.

Sulfur content of platformed gasoline is normally 0.005 per cent or less, with little effect of feed-stock sulfur content.

The process is applicable to conversion of C_7-ring as well as C_6-ring naphthenes to corresponding aromatics. Isomerization and hydrocracking of paraffins occur simultaneously with the aromatics synthesis, with the result that the residual platformer product, after aromatic removal, is still of suitable quality for motor fuel.

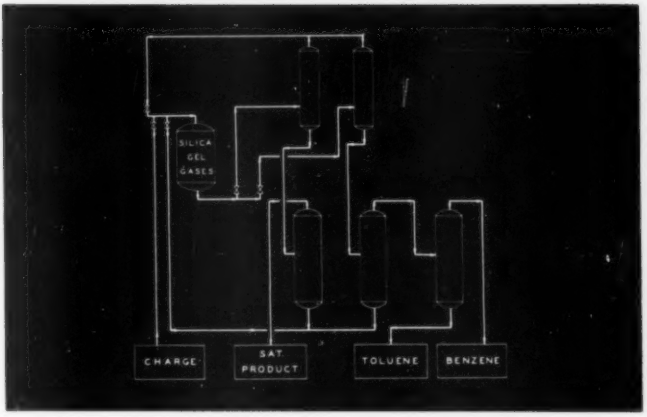
There are four major operating variables in the process. These are temperature, pressure, space velocity, and hydrogen recycle rate.

The Platforming process is a development of Universal Oil Products Co. and is licensed by that company.

Arosorb Process

The Arosorb process operates via selective adsorption to separate aromatics from a hydrocarbon mixture. Typical charging stocks for this operation are produced by catalytically reforming straightrun naphtha in any of the commercial processes. Silica gel is employed as the adsorbent in the process.

The fixed-bed adsorbent is contained in one or more cases. Feed stock is passed through the bed of silica gel which adsorbs benzene and toluene and allows paraffins, naphthenes, and other nonaromatic hydrocarbons to pass through. When the silica gel reaches its capacity for adsorbing the two aromatics, the feed stream is switched and the gel bed desorbed.



The process employs two desorbents. The first introduced to the saturated gel bed is butane, desorbent "B." This stream serves to displace, or wash the bed free of, the nonadsorbed hydrocarbons when its capacity has been reached. Butane is then followed by desorbent "A," which comprises mixed xylenes. Because of their high volumetric ratio to the benzene and toluene these mixed xylenes displace the lighter aromatics from the silica gel bed. The xylene stream is charged until all benzene and toluene are displaced from the gel case. This completes the cycle.

Throughout the cycle, rate of flow through the gel case is continuous. Switching of the effluent stream from each case is controlled by an instrument which is sensitive to a property of the mixed-hydrocarbons stream.

Other applications of the process are recovery of petroleum solvents and improvement of furnace and diesel fuels. It is adaptable to separation of a highly concentrated xylene mixture from higher boiling stock containing aromatics and aliphatics. Outside of the petroleum industry the process is applicable to separation and concentration of various chemicals.

The Arosorb process was developed on a commercial basis by Sun Oil Co. Davison Chemical Co. developed the special form of silica gel used in the operation.

Udex Process

Chemical-grade benzene, toulene, and xylenes are recoverable from a variety of wide-boiling aromatic-containing streams such as platformate via this process. One feature of the Udex process is that concentration of a given aromatic hydrocarbon in the feed stock to produce a high yield of nitration grade product, is not found necessary.

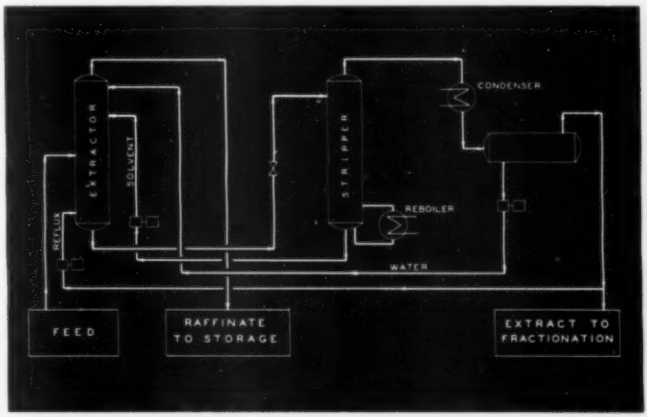
A glycol-water mixture which has both high selectivity and good solubility properties for aromatics in aromatic-paraffin mixtures is employed as a solvent. This solvent is immiscible with such mixtures throughout the entire range of aromatic concentration.

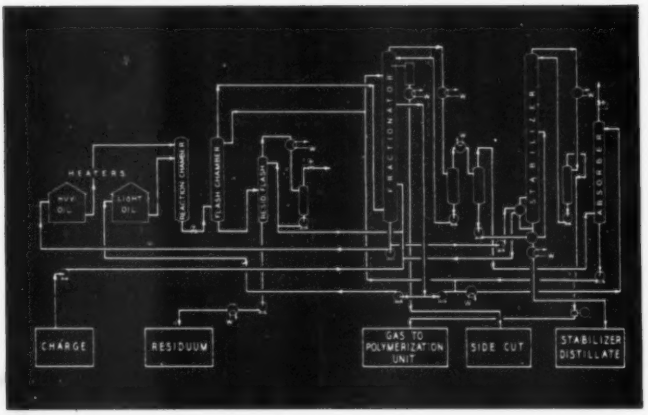
The process utilizes an extractor, the rich extract from which is fed into a solvent-recovery column wherein aromatics are stripped. Lean solvent is returned to the extractor. Aromatic concentrate recovered from the stripper is in part returned to the extractor as reflux, with the remainder fed to a fractionation system. Nitration-grade benzene, nitration-grade toluene, and a xylene-ethylbenzene concentrate of high purity can be obtained as products. Bottoms from the xylene fractionator represent a concentrate of C_9, C_{10}, and C_{11} aromatics.

The glycol-water system is noncorrosive and operating pressures are only those needed to maintain liquid phase conditions in the extractor. Consequently no high-pressure equipment or special alloys are necessary.

A typical Udex operation is illustrated in the case where a wet, wide-boiling-range platformate containing 63 mol per cent total aromatics is used as feed. Based on the aromatics in the feed stream, recoveries of 99 weight per cent of the benzene, 98 weight per cent on the toluene, and 91 weight per cent on the xylenes are obtained in the aromatic concentrate, which analyzed less than 0.2 mol per cent nonaromatics. Process steam consumption ranges from 10 to 15 lb. per gallon of feed to the reactor, depending on operating conditions.

The Udex process, a development of Dow Chemical Co., is engineered and licensed by Universal Oil Products Co.





Thermal Cracking

This is one of the earlier processes developed for production of gasoline from a wide variety of charging stocks. It also produces propylene and butylenes which can be polymerized to a high-octane blending stock for improving gasoline quality.

Thermal cracking may be carried out by various methods. One of the methods, two-coil operation, is shown in the accompanying diagram. In this operation topped or reduced crude is fed to the fractionating column where it is contacted with vapors from the flash chamber. Overhead fractionating column product is gasoline.

Furnace or tractor distillates are withdrawn as sidecuts and stripped to specifications. From a lower sidecut tray a higher-boiling distillate comprising lower fractions of both recycle and charging stocks is withdrawn as charge stock to the light oil heater.

The charge to the heavy-oil heater is withdrawn from the bottom of the fractionating column, and consists of the highest-boiling fractions of both the recycle and charging stocks.

The mixture leaving the reaction chamber enters the flash chamber in which a fuel-oil residuum of the desired properties is separated.

Cracking residual stocks at high-temperature levels results in cracked fuel oils of maximum stability and minimum sediment content. These properties are direct functions of the average temperature level of cracking. In the modern two-coil unit, average temperature of the entire reaction chamber is greater than the maximum temperature ordinarily attained in coil-only viscosity breaking.

Operation of the single-coil unit is similar to that of the two-coil unit with exception that recycle and fresh charge are cracked in one heater.

Yields and kinds of charging stocks for single-coil thermal cracking operation parallel those of the two-coil method discussed here.

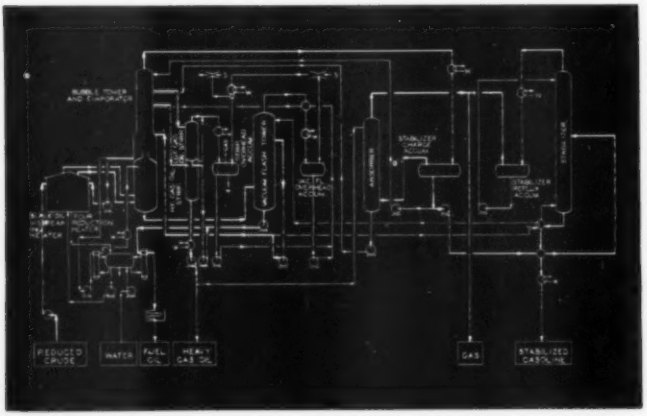
Thermal cracking processes are licensed variously. The accompanying flow diagram illustrates the flow scheme employed by the two-coil method of Universal Oil Products Co.

Visbreaking

Viscosity breaking and pour reduction are combined in this process to improve viscosity and pour of residual oils with minimum fuel oils and maximum gas oil production.

Low-viscosity fuel oils are produced from charge stocks of high viscosity and low pour point. The characteristics of the charging stock, the required products specifications, and the scope of refinery operations, determine the selection of the particular scheme of operation.

The Lummus Co. two-stage unit shown in the accompanying diagram has a wide range of operating flexibility. It is designed to process high-pour-point, high-sulfur-content reduced crude to minimum yields of low-pour-point, low-viscosity fuel oil and maximum yields of low-pour-point cracked gas oils. One coil is used for once-through visbreaking of the reduced crude and the oil cut is used for reducing the high-pour heavy gas oil produced in the first coil. Alternately, for a recycle visbreaking operation, both coils may be operated in parallel.

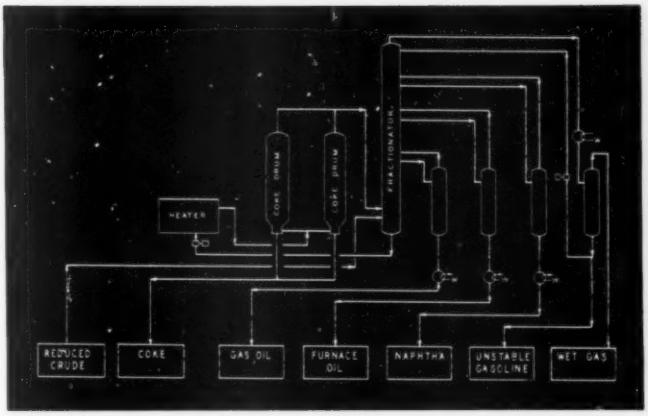


When heavy reduced crudes with gravities of 12.0° to 16.0° A.P.I., viscosities from 300 to 800 S.s.F. at 122° F. and pour points of 70° to 100° F. are processed in the two-stage unit, a finished fuel oil with a viscosity of 125 S.s.F. at 122° F. and a pour point of 20° to 25° F. is produced.

Aside from the relatively low yields of low-viscosity fuel oil and high yields of low-pour-point gas oils, this unit in addition produces approximately 20 per cent by volume of 10-lb. R.v.p. gasoline, having an A.S.-T.M. octane number of 70 when using naphthenic stocks. If the available residual charge stocks have a low pour point but a high viscosity, the production of low-viscosity fuel oil can be accomplished in a single once-through operation.

A design feature of the unit is the vacuum flash tower. This tower serves to reduce evaporator bottoms which are cut back with light cycle gas oil to produce a low-viscosity fuel oil.

Delayed Coking



The modern delayed-coking process is operated on a continuous-throughput basis to convert heavy hydrocarbons to lighter and more valuable products. Delayed coking operation differs from that of the usual thermal cracking process in that the topped crude, which is heated rapidly, flows to the coking drum where it is coked by its contained heat. Drum pressures depend on type of feed stock and desired yields.

Feed stocks for catalytic cracking may be prepared in the process. Such stocks are shown to be of high quality.

When processing a normal 30 to 40 per cent reduced crude, the charge is heated to 900° to 975° F. and transferred to the coke drums. These drums are maintained at temperatures up to 900° F. While light fractions vaporize and pass into the fractionator, the heavier oil is subjected to a long soaking period during which this heavier oil decomposes into lighter fractions and coke occurs.

Two or more drums may be used in sequence. When a drum is full of coke, it is disconnected and replaced by an empty drum. Usually the coke is removed hydraulically.

Vapors from the drums are fractionated in a bubble tower, taking gas and gasoline overhead and withdrawing gas oil (cat cracker feed) as a sidestream. Heavy ends from the fractionator are recycled back through the furnace in admixture with the fresh feed.

Octane ratings of the motor-fuel fractions from coking operations vary with the characteristics of the feed stocks. Asphaltic, naphthentic, and similar charges will yield motor fuels with an octane (motor method) of 70-73. Paraffinic stocks will show gasoline of 60-64 octane or slightly higher.

For a typical delayed coking operation, approximately 12 per cent by weight of the reduced crude-oil charge goes to coke, 4 per cent to gas, and the remainder to light liquid products. In a modern installation, enough drums, which are charged in rotation, are provided to allow continuous operation. The accompanying diagram is by M. W. Kellogg Co.

Contact Coking

Continuous contact coking, a thermal operation, converts heavy residuum oils and tars into coke and valuable light hydrocarbon products.

Essentially the process consists of applying a residual stock to a continuous stream of preheated coke particles produced in the process.

The preheated oil charge is thoroughly contacted with the circulating stream of preheated coke particles. The contacting zone is located at the top of the reactor.

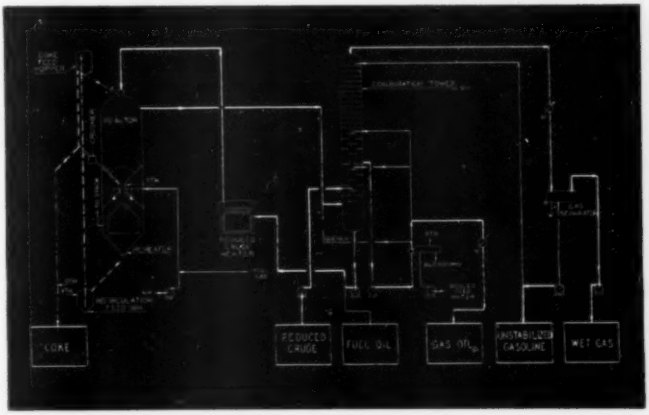
The hydrocarbon oils are distributed uniformly on the coke as a liquid microfilm without agglomeration of the circulative solids. The wetted coke particles flow uniformly through the reactor as a bed of free particles. The solids residence time in the reactor may be varied from 15 to 40 minutes, allowing the coking reaction to proceed gradually to complete conversion to product vapors and dry coke. Coke is deposited as a very thin layer on the original coke particles. The coke-stream passes from the bottom of the reactor through a sealing zone into a reheater, where it is heated by radiation and convection to the proper temperature for recirculation to the oil feed contact zone.

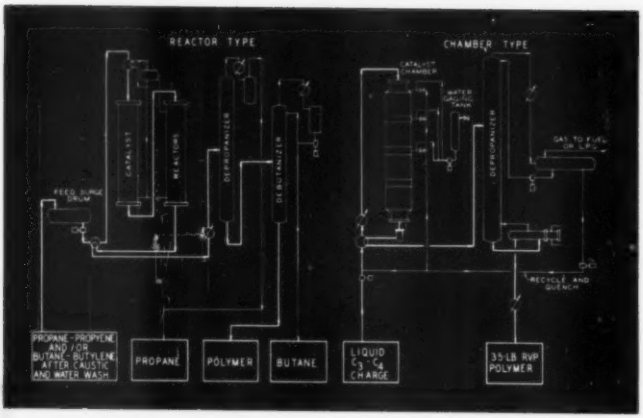
As the coking operation proceeds, there is an increase of coke inventory in the system and a general increase in particle size. Constant inventory is maintained by continuously drawing off a net coke product stream of the largest particles.

Vapors from the reactor are removed at the top, adjacent to the coke inlet, or at an intermediate level in the bed, and are quenched by the heavier recycle stream. The vapors are further fractionated in a conventional low-pressure tower to produce gas and gasoline, gas oil and bottoms.

Since the charge to the process is not subjected to elevated heater outlet temperatures, the product gas oil is given minimum thermal cracking. This results in production af a catalytic cracking charge nearly equal in quality to a virgin stock. Catalytic cracking charge stocks thus produced permit optimum yields and minimum coke formation. The process has unusual flexibility.

Lummus Co. supplied this diagram.





Polymerization

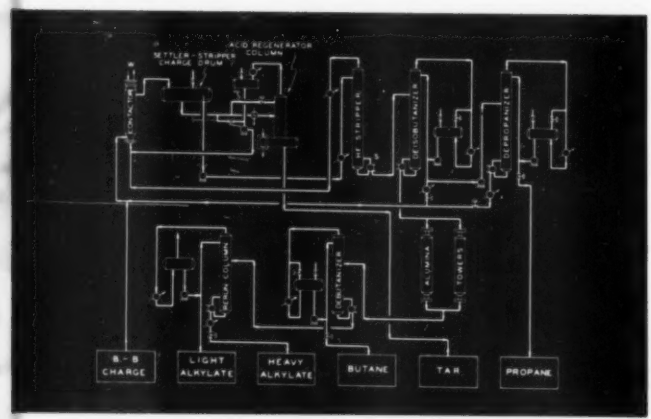
Catalytic polymerization converts a portion of the fuel gas produced in cracking operations into high-grade motor gasoline.

Polymerization of butylenes in absence of other olefins can be controlled to yield a product which on hydrogenation will rate 90-95 octane number. This is referred to as a selective polymerization.

Polymerization of propylenes in a mixture for production of a fuel for motor gasoline blending is known as nonselective operation.

Propylene can also be polymerized separately to make either a motor polymer or a product rich in either C_6, C_9, or C_{12} polymer. Two types of units are used, chamber and reactor.

This process is licensed by Universal Oil Products Co.



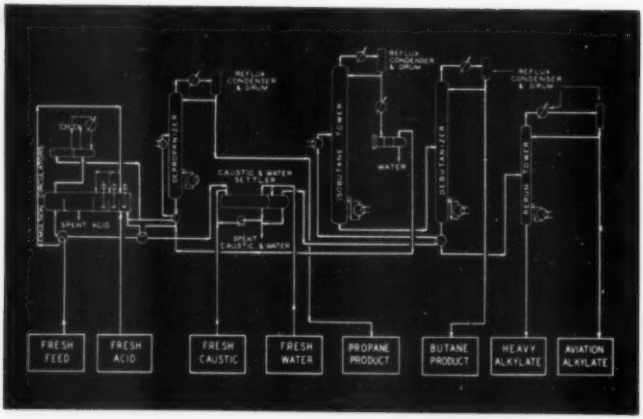
HF Alkylation

The HF alkylation process combines olefins, such as proylene, butylenes, and amylenes with an isoparaffinic hydrocarbon (usually isobutane) to form a mixture of branched-chain hydrocarbons of higher molecular weight.

Known as alkylate, the product is a mixture of saturated, stable isoparaffinic hydrocarbons distilling in the gasoline range. Because of its high octane number alkylate is used as the main component of aviation gasolines. During peacetime it is also added to motor gasoline.

Fresh feed is prepared by absorption and fractionation of light gases from catalytic cracking and related operations.

The process shown here is licensed by Universal Oil Products Co.



Sulfuric Alkylation

This alkylation process employs sulfuric acid as a catalyst. Yield is a low-volatility, high-octane product boiling within the gasoline range. This product, alkylate, may be added in any proportions to refinery gasolines to improve quality.

From a standpoint of motor-gasoline quality little difference is shown, outside of local economics, whether the alkylate is made from C_3, C_4, or C_5. For the average refiner only propylene and butylene feeds are of interest. Natural-gasoline-plant operators, however, may well be interested in C_5 alkylation.

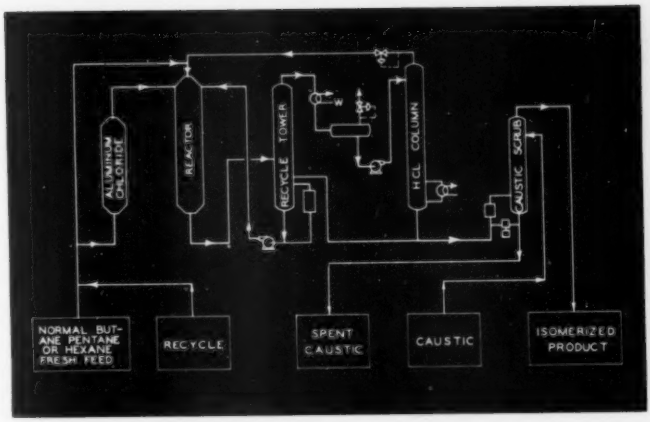
This process is licensed by M. W. Kellogg Co. who supplied the accompanying simplified diagram.

Isomerization

Isomerization is used for conversion of normal butane to isobutane to augment supplies of the latter for production of alkylate for aviation-gasoline blending. The process is also applicable to production of isopentane from normal pentane and for improving the octane number of hexane fractions.

Where normal butane or normal pentane is converted to corresponding iso-compound the recycle stream is the normal hydrocarbon. Where maximum octane number is desired in hexane isomerization, monomethyl pentanes as well as normal hexane are recycled to obtain maximum concentration of dimethyl butanes in the products.

The process shown here is licensed by Universal Oil Products Co.



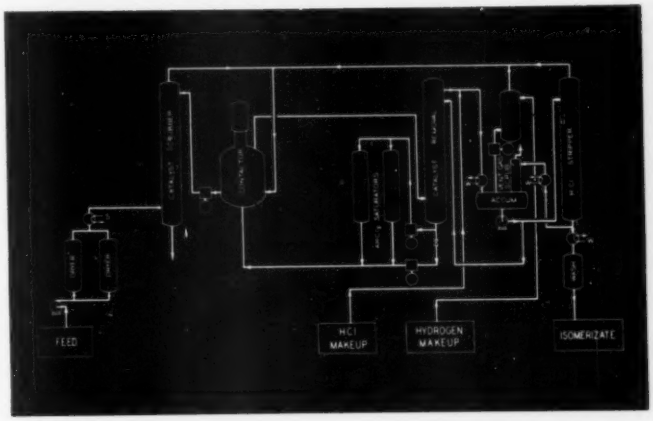
Liquid Isomerization

The Shell liquid-phase isomerization process is continuous and nonregenerative. Feed stock, normal butane or normal pentane, is contacted in the liquid state with a catalyst consisting of aluminum chloride dissolved in molten antimony trichloride.

Either butane or pentane may be converted to the corresponding isoparaffin in the same plant. The only additional equipment required are hydrogen compressor and its surge.

The small amount of noncondensable gas formed in the process is vented from the vapor space of the accumulator through a packed absorber. The HCl content of the vent gas is reduced to a minimum by a countercurrent wash with a cooled sidestream from the HCl stripper.

This process is licensed by Shell Development Co.



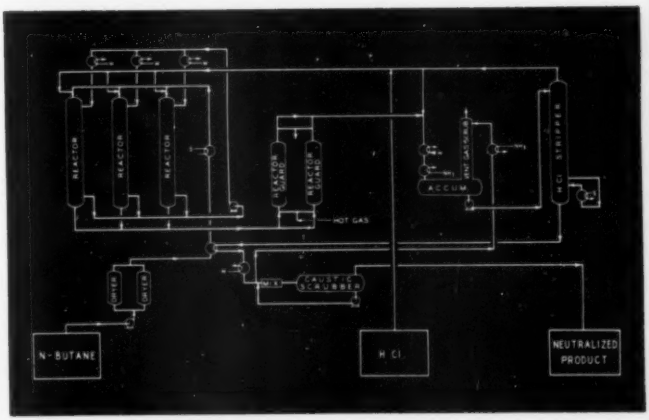
Butane Isomerization

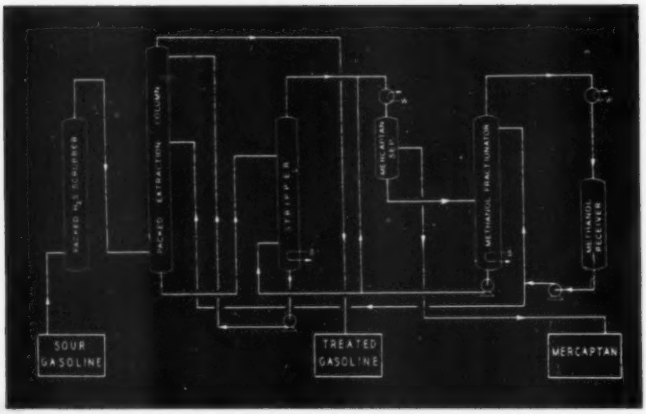
This process employs a catalyst in accomplishing conversion of N-butane to isobutane. The reaction is carried out in the vapor phase in reactors containing granular aluminum chloride catalyst.

The catalyst, specially developed for the process, consists essentially of granular alumina impregnated with anhydrous aluminum chloride. Although the catalyst is resistant to poisons, most of the olefins and pentanes must be removed from the feed as they destroy catalyst activity.

A reactor for this process may have a single catalyst bed, or it may be of the heat-exchanger type. As the isomerization is reversible, feed should contain as little isobutane as possible.

This process is licensed by Shell Development Co.



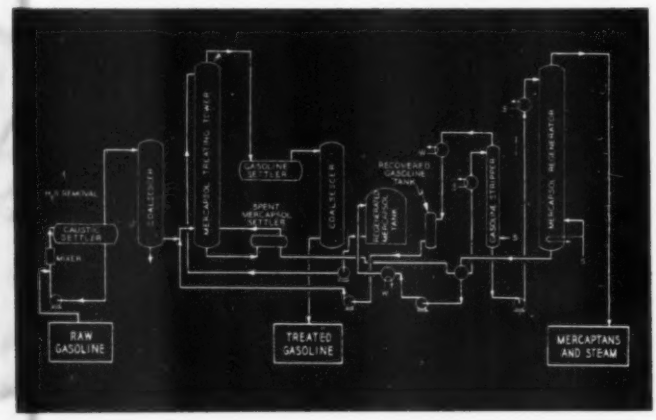


Unisol Process

This process extracts mercaptan compounds from gasoline and higher-boiling fractions. The process is based on increase in solubility of mercaptans in caustic soda solutions when an organic solvent, methyl alcohol, is present. Mercaptan reduction of better than 99 per cent is accomplished by the process.

Recent modifications enable removal of 95 per cent or more of the mercaptans from various distillates. Pyrrole-type nitrogen compounds are also removed by the process. Removal of these compounds markedly reduces color and sediment-forming tendencies in distillate oils as well as producing an oil of marketable odor.

The Unisol process, a development of Atlantic Refining Co., is licensed by Universal Oil Products Co.



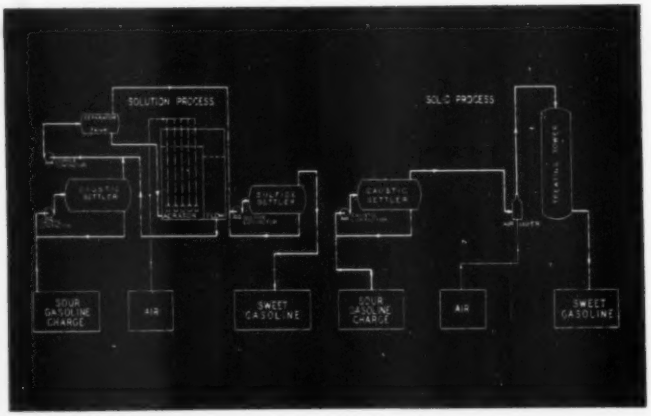
Mercapsol Process

The Mercapsol process removes mercaptans from gasoline by extraction with an aqueous solution of caustic soda fortified with certain solubility promoters. These solubility promoters act as hydrotropic salts and greatly increase the solubility of mercaptans in the aqueous phase.

Continuous countercurrent extraction is carried out in packed or tray tower, multistage mixer-settler system, or other efficient liquid-liquid contacting device. Prior to mercaptan extraction, the gasoline is given a wash with low-strength (5 to 10 per cent) caustic solution.

A coalescer after the prewash step further protects the solution from contamination; a settler and coalescer clarify gasoline from extractor.

Pure Oil Co. is licensor of this process.



Perco Sweetening

This method of sweetening is applied in two ways. Where the stock to be treated is sufficiently stable in color and gum when treated in presence of air, the solid process is applicable.

In the solution process other stocks are continuously treated with the copper solution in the absence of air. Stocks treated with the copper solution are given a final sodium sulfide wash.

In either process, where the gasoline to be sweetened contains hydrogen sulfide, this component is removed by a caustic-washing step prior to the sweetening operations. Likewise, free sulfur is removed by a caustic-polysulfide prior to sweetening.

This process is licensed by Perco Div. of Phillips Petroleum Co.

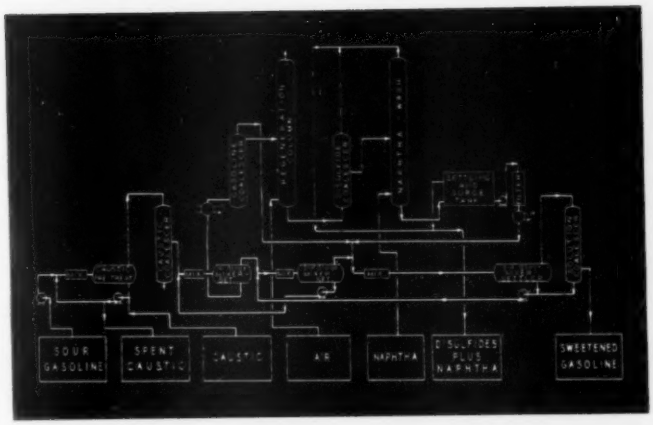
Tannin Solutizer

The Shell tannin solutizer process is carried out in two steps—extraction and regeneration for removal of mercaptans from sour gasoline.

In the extraction step, sour gasoline is brought into intimate contact with strong caustic solution containing, besides a small amount of tannin, mercaptan-solubility promoters (solutizers) such as fatty acids, e.g., propionic and butyric acid, and/or alkyl phenols.

Tannin serves to catalyze the oxidation of extracted mercaptans to disulfides in the regeneration step. These are removed from the solutizer solution prior to its recycle to the extraction operation.

Shell Development Co. is licensor, under its and Socony-Vacuum patents.

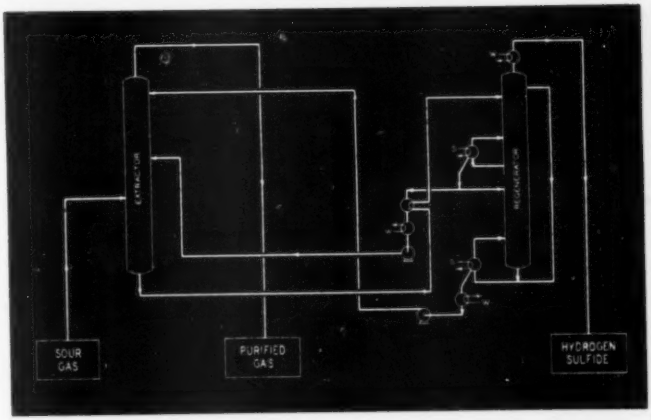


Phosphate Desulfurizing

The Shell phosphate process is applicable to recovery of H_2S from which elemental sulfur is to be made. For that purpose the recovered H_2S must be of high purity, i.e., with minimum CO_2 and hydrocarbon content. The process consisting of two steps, absorption and regeneration, removes H_2S economically from refinery and natural gases containing CO_2 and H_2S in ratios as high as 20 to 1.

The tripotassium phosphate solution removes H_2S selectively in the presence of CO_2. This feature of the process may be highly advantageous in desulfurization of natural or synthetic gases. In such cases it is often undesirable or unnecessary to remove all the CO_2 along with H_2S for reasons besides the higher attendant stripping steam consumption.

This process is licensed by Shell Development Co.

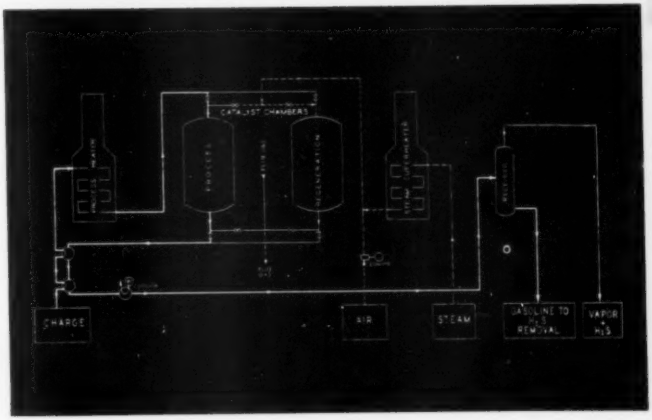


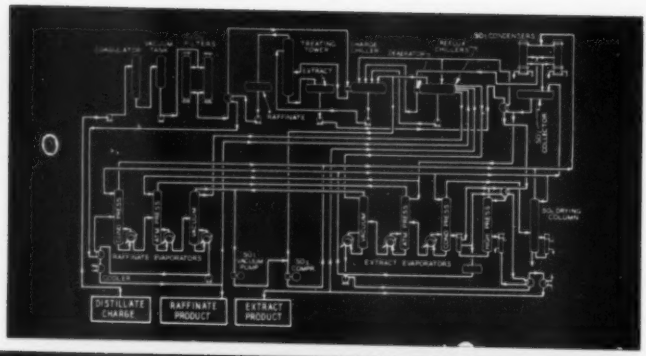
Catalytic Desulfurizing

The Cycloversion catalytic desulfurization process is used to lower sulfur content of gasolines. Types of sulfur compounds removed by the process include mercaptans, sulfides, and disulfides—the cyclic compounds are not greatly affected. The variation in quantity of cyclic compounds present in the above-mentioned types of gasoline accounts for the differences in reduction of total sulfur content.

Basically, operations of this process result not only in "desulfurization" but also in a "catalytic" effect, producing improvement in octane and in TEL response not otherwise obtained merely by conventional methods for sulfur removal.

This process is licensed by Perco Division, Phillips Petroleum Co.



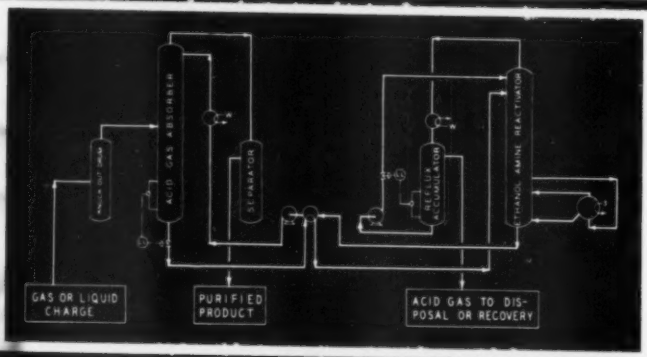


Edeleanu Process

The Edeleanu process is employed in the refining of naphtha, kerosine, gas oil, and light lubricating oils. It is equally suitable for treatment of medium and heavy lubricating oils, but for that purpose it must be used under temperature and pressure conditions making application less attractive from a practical standpoint.

The process is a selective extraction one, employing liquid sulfur dioxide as the solvent. All solvent recovered from the products is ultimately liquefied and returned to the system.

Diagram by E. B. Badger & Sons Co.

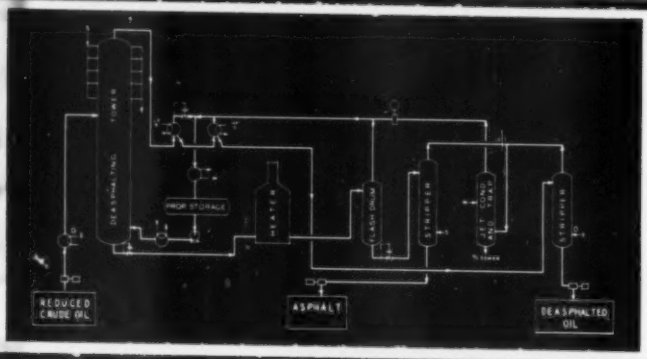


Girbotol Process

The Girbotol process is a continuous cyclic one employed for purifying refinery and natural gases and hydrocarbon liquids and for separation of carbon dioxide from synthesis gas mixtures.

Gases and liquids are scrubbed with solutions of amines (organic alkalis) which remove acidic gases from them. The absorbed acidic gases are then separated from the amine solutions by heating which regenerates the solution for further acid gas absorption.

Girdler Corp. is licensor of this process.

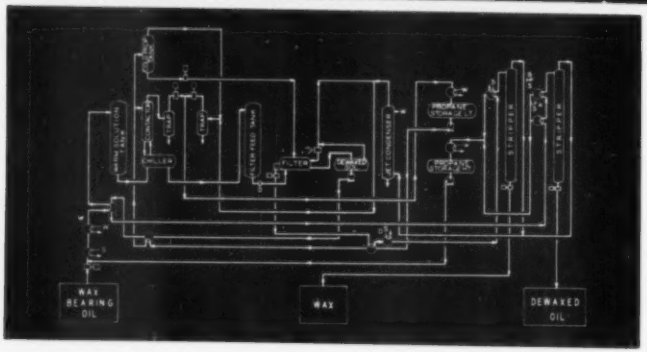


Propane Deasphalting

This deasphalting process employs propane as a solvent for the purpose of separating by liquid-to-liquid extraction, asphalt, color bodies, and other undesirable constituents from reduced crudes.

The process is also employed for fractionation of the deasphalted oil into two or more portions. By a simple variation of operating conditions, the highly viscous oil portions of reduced crudes may be separated into as many different fractions as is desired.

Licensing agent for this process is M. W. Kellogg Co.



Propane Dewaxing

The propane dewaxing process is employed for separating wax from crude oil in lubricating-oil manufacture. Propane is the only extraneous material used, serving both as a refrigerant and a solvent for the oil.

Typical of some stocks being treated by propane dewaxing are those from Mid-Continent and East Texas crude oils. With prior treatment by propane deasphalting and phenol extraction, heavy distillates and other lubricating stocks from these crude oils respond readily to propane dewaxing.

M. W. Kellogg Co. is licensing agent for this process.

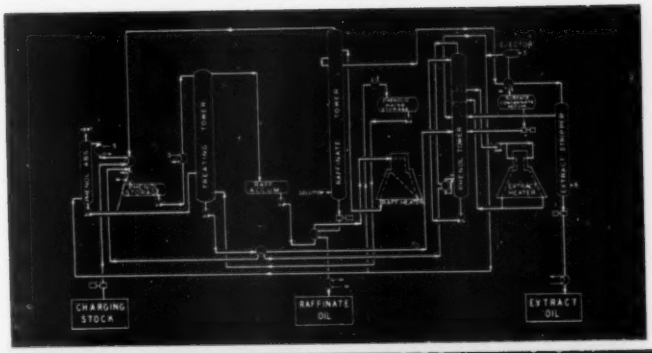
Phenol Extraction

This is a liquid-liquid extraction process for improving viscosity index and oxidation resistance, and for reducing carbon and sludge-forming tendencies for lubricating oils.

The solvent is continuously reused, with low losses (0.01 per cent of the total solvent circulated per day).

Used in conjunction with propane deasphalting, the process removes naphthenic acids thoroughly and handles stocks of high sulfur content satisfactorily.

M. W. Kellogg Co. is licensing agent.

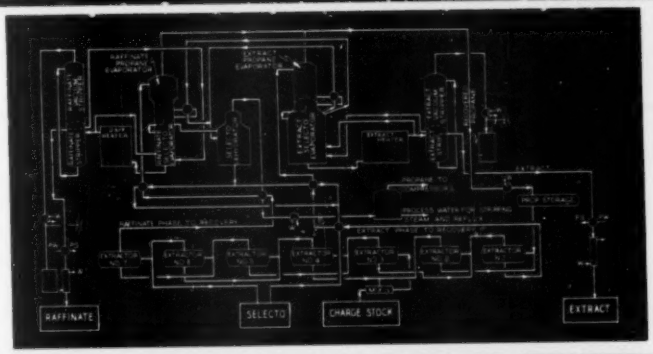


Duo-Sol Process

Two solvents are used countercurrently in the Duo-Sol process for manufacture of lubricants. Propane, which has a high solubility for the raffinate, is one of the solvents. The other, known as selecto (a blend of cresol and phenol), has high affinity for the extract. The solvents themselves have only limited solubility for each other.

The process produces fine-colored oils having low carbon residue and good stability.

Duo-Sol is licensed by Max B. Miller & Co.

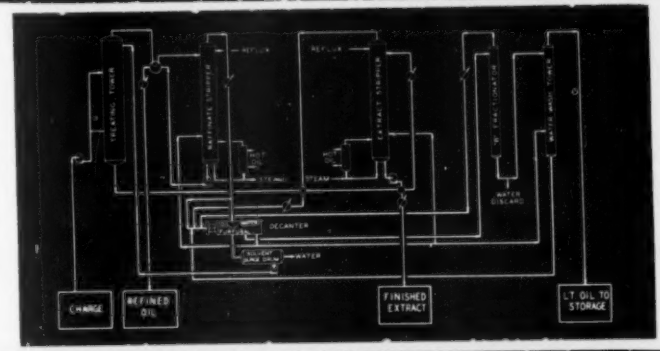


Furfural Extraction

Furfural extraction removes from diesel fuel oil, burning oils, and cracking stocks, materials having low cetane number as well as such undesirable materials as unstable acidic, sulfur, organo-metallic, and nitrogen compounds.

The process is characterized by its low solvent requirement. This runs from 25 per cent of charge when extracting cycle gas oil for recharge to cat cracking to about 80 per cent in processing virgin gas oils.

Texaco Development Corp. is licensor of this process.

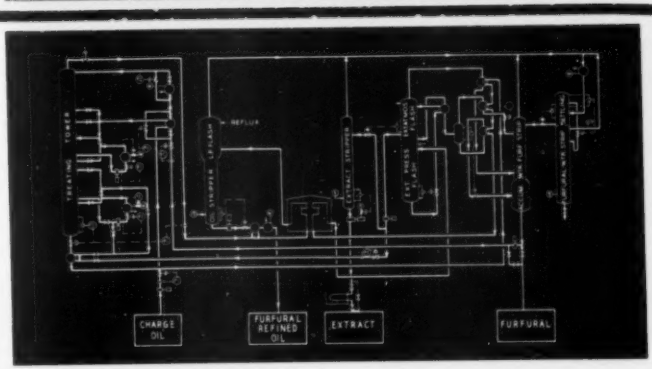


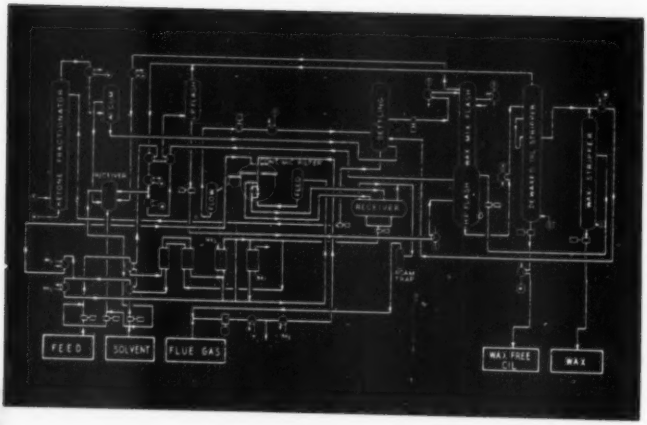
Furfural Refining

Furfural refining is employed in the production of high-quality finished lubricating oils. The process is applicable to a wide variety of stock oils, using furfural as a selective solvent to extract undesirable components.

The boiling point of furfural is sufficiently low to permit its recovery from the lightest lubricating-oil stocks without loss of oil or critical loss of solvent. It has a low solid point, eliminating danger of solidification. Furfural's high specific gravity insures complete rapid separation.

Furfural refining is licensed by Texaco Development Corp.





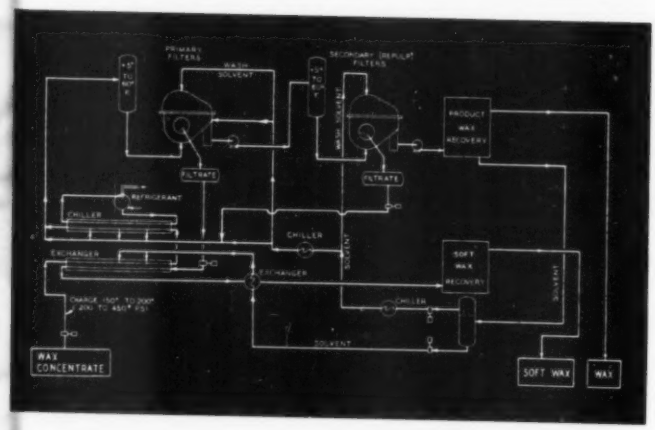
Solvent Dewaxing

This solvent dewaxing process generally employs a mixture of methyl-ethyl-ketone and an aromatic solvent (benzene, toluene, or a mixture of the two) to obtain a dewaxed-oil pour point equal to or within a few degrees of the dewaxing temperature.

The dewaxed oils are free from wax cloud and there is no rise in pour point or "pour reversion" on aging. Either distillate or residual stocks in the raw state or refined, of any viscosity, can be dewaxed.

Due to low solubility of wax in the solvent, low pour tests can be obtained at relatively high separation temperatures. Practically complete separation of oil from wax is obtained via a cold displacement wash.

Texaco Development Corp. is licensor of this process.

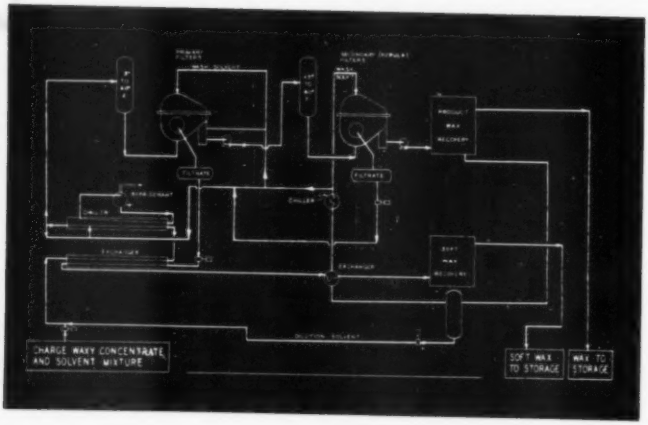


Wax Manufacturing

This process yields waxes of high quality and of precise fractions not normally obtained by other methods. Crystalline and microcrystalline waxes with melting points ranging over broad limits depending on nature of the charge stock, can be produced by the process.

Operation of the process is continuous and economical in use of solvent whether producing regular grades of white crystalline wax and dewaxed neutral oils or high-melting-point microcrystalline wax from distillate or residual oils.

Wax manufacturing is a development of Texaco Development Corp. and Union Oil Co. of California. Texaco Development Corp. is licensor for the process.



Wax Fractionating

This process produces wax of low oil content. The solvents employed are generally the same as those used in the solvent dewaxing process (ketones and aromatics). Wax cake (wax and solvent) from a dewaxing operation may be charged directly to wax fractionation operations without first recovering the solvent from the wax, thus simplifying operations.

The process may be used independently of solvent dewaxing to produce high-quality waxes from concentrates obtained from other sources. Depending on source of raw waxy concentrate, crystalline waxes of high melt point and low penetration may be produced without additives.

This process is licensed by Texaco Development Corp.

Corrosion

SECTIONS AND ARTICLES

IN THIS ANNUAL REFINING NUMBER

The Oil and Gas Journal publishes significant articles on the important subject of corrosion. The authors include experts with several of the major oil companies. There also are illustrated pages on "How To Combat Corrosion In Processing Oil and Gas."

Appearing first in this corrosion section (edited by John C. Reidel, Journal district editor) are practical answers dealing with engineering corrosion questions.

Corrosion Types—Causes and Prevention

Ques.—What are some general anti-corrosion methods?

Ans.[1]—Four general methods for attacking a specific corrosion problem are: (1) substitution of a more resistant metal or alloy for the part suffering from corrosion, (2) treatment of the corrosion medium so as to render it less aggressive, (3) application of a coating to separate the attacking medium and the surface being damaged, and (4) cathodic protection. These four methods are by no means mutually exclusive; more often than not a combination of two or more of them is found superior to any one alone. An example is the use of coating plus cathodic protection on pipe lines.

1. Galvanic Corrosion

Ques.—How does galvanic corrosion take place?

Ans.[1]—The behavior of a flashlight dry cell is analogous to the galvanic cells found in pipe. The electricity that lights the filament is a result of placing two dissimilar metals, carbon and zinc, in an electrolyte, and connecting them externally with a wire. In producing the current, zinc, the anode is corroded. It is certain that many people have had the experience of having the outer shell of a dry battery break through in a pit hole after continued use.

In a like manner, the wall of a buried pipe—such as in underground refining installations — may corrode through in a pit hole when the pipe, or a portion of it, is the anode of a galvanic cell.

Where the current leaves the pipe, the anode area, the pipe will be corroded. Where it returns to the pipe, the cathode area, a thin film of hydrogen will be deposited on the surface of the pipe. The film of hydrogen, if it remains on the surface of the cathode, acts as an insulator and tends to stop the flow of the galvanic current (polarization).

Ques.—After renewing a short section of line, why does the new piece of pipe seem to corrode even faster than the original?

Ans.[1]—Corrosion caused by dissimilar metals is illustrated when a brass core or all-brass stop, such as a brass valve, is installed in a steel line. Here the brass is the cathode and the steel pipe the anode. Fortunately, the area of the brass is small with respect to the steel pipe surface area. Corrosion should not be severe since a large-area anode supplies current requirements of a small-area cathode.

However, the reverse is true when a relatively small piece of new pipe is installed in an old line. The new steel pipe will always be the anode of a galvanic cell, created by mechanically connecting the old and new lines. If a very short piece of new pipe is installed in an old line the corrosion may be accelerated because the small anode will be required to supply current to satisfy the much larger cathode area of the old pipe.

Ques.—In discussion of galvanic corrosion, use of the electromotive series of metals is often brought up. What practical use can be made of this table?

Ans.[2]—Reference to the electrochemical series cannot adequately explain all the instances of occurrence and nonoccurrence of galvanic action. First, the electrochemical series gives the potentials exhibited by the various metals under one very specific set of conditions. Each metal is compared to a hydrogen electrode, is placed in a standard solution containing its own ions and no other metallic ions, and the values are determined at standard temperatures and pressures. In any other solution, at any other temperature, the potential difference will be something else.

Second, the potential difference between two metals is merely an indication of the initial tendency toward corrosion. Under certain conditions of hydrogen evolution at the cathode, a film of very high resistance may be formed so that the corrosion rate is enormously reduced. There are numerous other corrosion products which can stifle corrosion by increasing the resistance of the cell formed.

From all of the above complexity and confusion it is difficult to draw any simple conclusions. However, in absence of information as to behavior of given metals and alloys and of environment, it is well to avoid the use in electrical contact of metals which lie very far apart in the electrochemical series; it is advisable to separate them electrically if possible; and it is always good practice to make the anodic metal the one with the larger exposed area.

Note: References documenting the "Answers" appear on page 224.

Ques.—Why is the new line damaged when you lay a new line alongside an old one and connect the two with crossovers or headers?

Ans.[1]—Because it creates a galvanic cell which, except for the ratio of surface areas, is exactly the same sort as that produced by installing new pipe in an old line.

Ques.—Why is it that a section of screw-coupled line will develop bad pit holes, either right alongside or just a few inches out from the fitting?

Ans.[1]—The chances are that the pit hole was the anode of a galvanic cell created by a dissimilarity of surface conditions. The scratches made by using a pipe wrench, or the bright surface of the shallow threads adjacent to a fitting, will be anodic to the rest of the pipe. Because their relative area is small, such anodes are often extremely active.

Ques.—In addition to dissimilarity in metals how else may galvanic currents be produced in buried lines?

Ans.[1]—These currents are also produced by dissimilar soils such as top soil, clay, loam, and shale; by dissimilar surface condition or finish, such as scratches made by a pipe wrench; by dissimilar aeration of soils, that is, loose backfill and undisturbed soil on the bottom of the ditch, to name just a few of the more important dissimilarities.

Ques.—How can these galvanic cells be avoided or counteracted?

Ans.[1]—Some can be avoided by proper design before construction. Others are unavoidable or have already been built in, but can be counteracted by one of several treatments, such as using impressed currents, by installing expendable anodes, or by using pipe coatings having an electrical insulating value.

Ques.—Which types of metal will form strong galvanic cells when combined with iron?

Ans.[1]—There are three readily available metals, aluminum, zinc, and magnesium, each of which will form reasonably strong galvanic cells when combined with iron. Any one of the three can be used to construct this galvanic cell. Magnesium forms the strongest cell of the three, and is therefore most often used.

Ques.—How does magnesium work?

Ans.[1]—The magnesium ingot is the expendable anode, the soil is the electrolyte, and the pipe surface the center cathode. An insulating wire, with one end soldered to the pipe and the other end to the magnesium, completes the electrical circuit. Current will flow from the magnesium to the ground, taking metal ions of magnesium with it. It then flows through the ground onto the pipe, counteracting the natural galvanic cells.

Ques.—How can this protection be applied?

Ans.[1]—The practical application is simple. Any time it becomes necessary to replace a short piece of line, two or three anodes, or one anode for each 20-ft. joint, can be installed at the same time in the same ditch with the pipe.

2. Graphitization

Ques.—What is graphitization?

Ans.[17]—While steel is normally a mixture of ferrite and cementite, this mixture is thermodynamically unstable. Prolonged exposure at elevated temperatures decomposes the cementite into its elevents, iron (ferrite) and carbon. The latter will take the form of graphite which is soft and weak. The process of this conversion is known as graphitization.

Ques.—Of what importance is graphitization to the refining industry?

Ans.[18]—Interest in graphitization has come about due to the failure of some reactors in the spring of 1951. Samples taken from one of the reactors showed that the carbon steel base metal was graphitized.

Ques.—What conclusions have been reached with regard to graphitization as it concerns petroleum-refining equipment?

Ans.[18]—To date it has been decided that:

1. Damaging effects of graphite in refinery equipment to the degree experienced by the power industries is not obvious at this time.
2. Graphitization does not appear to be solely responsible for the cracks in three integral-clay reactors.
3. Added limitations on the use of carbon steels in refinery equipment appear unwarranted at this time in view of the limited hazard of graphitization so far established.

3. Steel Embrittlement

Ques.—How may steel embrittlement be identified?

Ans.[15]—The type of embrittlement restricted to equipment handling caustic, basic waters, and to a minor extent, nitrates and phosphates, can be identified by three characteristics:

1. Location and occurrence of cracks.
2. The obviously brittle nature.
3. Appearance of polished specimens under the microscope.

The appearance of a microsample is the most distinguishing characteristic. The typical embrittlement crack is not a single line of penetration, but is a honeycomb of fine cracks. Careful observation of an etched specimen will show that such failures are predominantly intercrystalline, i.e., the cracks follow the grain boundaries.

Ques.—What are causes of embrittlement failures?

Ans.[15]—A combination of at least three basic factors is necessary to produce this type of failure:

1. A concentrate alkaline solution.
2. High metal stresses.
3. Temperature.

Embrittlement cracks are usually considered to be of two types: (1) Boiler embrittlement, and (2) caustic embrittlement. Actually these are identical in nature, the only difference being that in the case of boiler embrittlement some mechanism is required by which an alkaline solution can be concentrated.

Ques.—What has been some experience with caustic embrittlement?

Ans.[19]—A flow diagram of a typical caustic-treating unit is shown in Fig. 1. The acid-treated naphtha enters a caustic-treating drum "A," at elevated pressure and temperature and is sprayed with 20° Be. caustic. The caustic-treated naphtha flows to an auxiliary settling drum "B," where

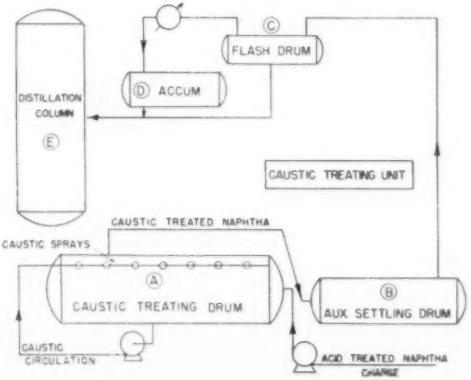


Fig. 1—Caustic treating system.

most of the entrained caustic settles out. The flash drum "C," operates at low pressure and the condensate accumulated at "D," is added to the treated product and distilled in tower "E."

Failures occurred in almost every part of the treating system from the caustic injection point up to and including the flash drum and condensate accumulator, except drums "A" and "B," which had been thermally stress relieved. All failures were intergranular in nature, similar to the examples already mentioned.

Ques.—What are some conclusions following observation of caustic-embrittlement failures?

Ans.[15]—A number of facts appear conclusive:

1. Caustic-embrittlement cracks are predominantly intergranular.

2. Caustic strength in many refinery operations is sufficient to cause cracking of low-carbon steel.

3. Temperature is an important factor in that it speeds up chemical reaction between caustic and steel.

4. Welding stresses and bending stresses are sufficient to cause caustic-embrittlement cracking in plate and pipe at 315° F. even where sound welds are obtained. Poor fitup and poor welding greatly increase the probability of cracking.

5. Stress relieving welds and pipe bends is sufficient to eliminate caustic-embrittlement cracking on wrought steel, except in cases where poor welds are made.

4. Hydrogen Attack

Ques.—How does hydrogen attack of low-carbon steel take place?

Ans.[16]—The solubility of hydrogen in steel is appreciable, and it increases with an increase in temperature. Molecular hydrogen diffuses through steel very slowly, if at all. Atomic hydrogen diffuses through steel very readily. It is believed that the manner in which hydrogen leaks out of a blister over long periods of time probably results from the fact that hydrogen dissociates to a limited degree at any temperature, and that the atomic hydrogen thus formed leaks off.

If the rate at which hydrogen enters steel is greater than the rate at which it leaves the steel, internal pressure will build up within the steel until either these rates become equal or the steel ruptures. The pressure required to rupture the steel depends on the strength of the steel which, in turn, depends on its homogeneity and physical properties.

Atomic hydrogen thus formed on corroding steel originates from the hydrogen ions in water. As a result of the action of such corrosion cells, a high concentration of atomic hydrogen exists on the corroding surface. From this surface it may diffuse into the steel.

Ques.—How may such attack be prevented?

Ans.[16]—When hydrogen damage occurs in refinery equipment, the atomic hydrogen is supplied by the naturally occurring corrosion cells. Obviously, elimination of the corrosion reactions will eliminate the supply of hydrogen, and thus stop the attack. Another alternative is modification of the catalytic nature of the steel surface so as to reduce the acceptance of atomic hydrogen by the steel.

Although hydrogen attack may be reduced by alloy or alloy-clad steels and certain surface coatings, elimination of the hydrogen source is the only practical solution.

Ques.—At what points in cat cracker gas plants is hydrogen attack likely to occur?

Ans.[16]—A simplified flow diagram for a typical catalytic cracking gas compression plant is shown in Fig. 2 and a simplified flow diagram for an absorption and fractionating plant is shown in Fig. 3. Individual plants may vary in details of equipment and in operation; but these flow diagrams represent the simplified basic features of most plants, and they are presented to indicate the locations where hydrogen blistering, fissuring, and embrittlement are likely to occur. They are presented as a composite of the experience of various refiners. No single plant has experienced hydrogen attack in all of these locations.

Ques.—What are the effects of hydrogen penetration on steel?

Ans.[16]—High internal hydrogen pressures in steel may cause blistering, fissuring, or embrittlement. The pressure which is built up in the steel will cause rupture at the weakest part. In dirty steel the weakest part may be an inclusion or lamination, whereas in clean steel the weakest part may be the slip planes or rifts within the grains themselves. Loss of ductility is caused by the high strain produced by hydrogen pressures

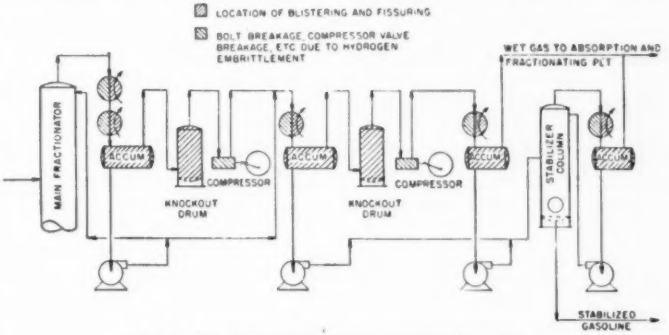


Fig. 2—Catalytic cracking gas-compression plant.

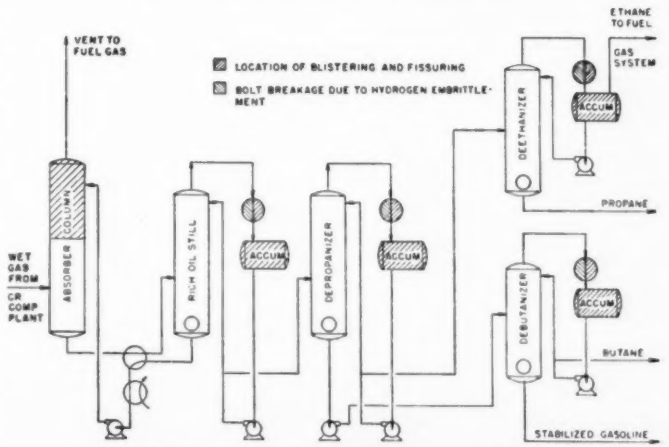


Fig. 3—Absorption and fractionation section.

which occur in submicroscopic voids. The hydrogen pressures which can be attained in discontinuities are of an extremely high magnitude, and far exceed the strength of the steel.

Ques.—What happens to the ductility of the steel?

Ans.[10]—When steel is penetrated by hydrogen, it suffers loss of ductility. Inasmuch as the diffusion rate of atomic hydrogen into and out of steel are about the same, the loss of ductility of a piece of steel exposed to corrosive conditions may not be detected if the piece is tested several hours after its removal from the corrosive environment. This factor accounts for the apparent satisfactory ductility in specimens of steel removed from blistered vessels when they have been tested days or weeks after the vessel was removed from service.

The loss of ductility in the type of mild steels used for refinery pressure-vessel construction might not be considered to be too serious. However, the combined effects of embrittlement and the high stress concentrations which result from fissuring or blistering are of much concern.

Ques.—What factors of environment are involved in occurrence of hydrogen attack?

Ans.[10]—Greatest hydrogen damage is experienced where hydrogen sulfide is present. In solutions of relatively pure water and hydrogen sulfide little hydrogen penetration damage results. If acids are present, rapid and continuing hydrogen damage can be expected. Still greater damage occurs if cyanides and ammonia are also present.

Ques.—What measures may be taken to mitigate hydrogen attack?

Ans.[10]—In the absence of cyanides, hydrogen penetration in acidic hydrogen sulfide solutions may be reduced by ammonia injection. However, this method usually is too costly.

Extensive water washing of petroleum stocks causing hydrogen penetration damage is effective in greatly reducing this damage. However, washes with inadequate amounts of water may enhance deterioration, rather than relieve it.

Cathodic Protection—Condensers And Heat Exchangers

Ques.—Are coatings practical for the protection of the water side of condensers and coolers?

Ans.[1]—Coatings as they are usually known are impractical for the reason that a good electrical insulator is also a good heat insulator and the reduction in effectiveness of heat transfer defeats the primary purpose of the equipment.

Ques.—How about treatment of the corroding medium?

Ans.[1]—This is sometimes practical in heat exchangers and in condensers using a closed cooling-water system; but where the water is used only once the volume handled is too great to be conditioned at reasonable cost.

Ques.—What has been the classic approach to the problem of condenser-tube corrosion?

Ans.[1]—Use of metals or alloys which show superior resistance to attack has proved quite successful in the large majority of cases, insofar as the tubes themselves are concerned. One difficulty encountered, however, has been galvanic or bimetallic corrosion set up by the presence of the alloy tubes and steel tube sheets, headers and shells. In these combinations the tubes themselves are invariably cathodic, so that the attack is directed against the steel parts.

The tube sheets, being the nearer parts, are most often the more strongly attacked. Substitution (at considerable cost) of resistant alloys for the tube sheets transfers the attack to the shell, where the reduced relative area of the anodic section makes the attack all the more violent.

Ques.—How may the galvanic corrosion referred to above be combated?

Ans.[1]—This condition has been successfully combated by the installation of magnesium anodes in the water box. The protecting current will not "throw" more than two or three diameters down the tubes themselves, so the cathodic protection alone is not a satisfactory solution. If, however, a suitably resistant alloy can be found for the tubes, the cathodic protection can be used to overcome the galvanic potentials between the alloy and steel sheets and headers, and a more economical design effected thereby.

Ques.—What about the use of slab-type anodes?

Ans.[1]—Recently there has been introduced a 17-lb. slab-type anode, designed to be attached to a flat steel surface by a single ½-in. stud or bolt. Excessive current flow to the immediately adjacent surface, with attendant loss of anode material, is prevented by using a sheet of rubber or saran beneath the anode. With unusually low water resistivity, as for sea water, current output of anode is limited through use of an insulating washer with a self-contained resistor placed under the nut holding the anode. By this means the resistor is included in the circuit and the current flow is thereby reduced to the desired value.

Ques.—How may anodes be installed in the coil-in-box or shell-and-tube equipment?

Ans.[1]—Anodes in the form of threaded lengths of an extruded magnesium alloy rod may be mounted by threading into half-collars welded in place inside the water box, at locations so spaced as to give reasonably uniform distribution of current to all the surfaces requiring protection.

Similar rods may be installed in special internally threaded pipe plugs screwed into threaded openings in the shell. This simple installation, however, does not afford any means of measuring or controlling the current output and the degree of protection obtained and life of anode expected must be estimated. No great hardship is involved, since equipment of this nature is usually opened for inspection at regular intervals under any circumstances.

Ques.—How may the anode life be estimated?

Ans.[1]—As a preliminary estimate the exposed area of metal (not including the tubes) should be provided with 10 ma. per square foot—a value which may be changed later on the basis of experience. Total dissolved solids in the water are determined by chemical analysis. This forms a convenient basis for estimating current output of each anode. For a 1.315-in. magnesium rod (1-in. pipe size), the current output may be approximated by:

$$I \text{ (ma. per foot of rod)} = \frac{\text{p.p.m. total dissolved solids}}{13}$$

This gives a rough approximation of steady-state current flow after initial polarization to protective potentials has been obtained. Total output of 1.315-in. rod may be estimated at 60 ma.-years per foot, from which estimate of anode life may be made. If the equipment is opened for inspection after about half the estimated anode life has elapsed (unless scheduled sooner), anode consumption can be estimated. From this a revised estimate of anode life and an approximation to actual current being obtained may be made.

Ques.—What has been the experience with cathodic protection when used to retard or prevent water-side corrosion in open-box coil coolers?

Ans.[1]—As an example, experience with installations at the Baton Rouge refinery of Esso Standard Oil Co. has been described.

Ques.—What was the corrosion problem on the Baton Rouge installations?

Ans.[1]—Corrosion on the water side of the tubes in the form of tubercules

resulted in deep pitting and short life. Recirculated cooling-tower water and raw Mississippi River water are used as coolants at Baton Rouge.

Ques.—Why was cathodic protection chosen?

Ans.'—Cathodic protection appeared to have low initial and operating costs and replacement pipe coils would not be required. It was also desired to determine the practicability of cathodic protection on this type of equipment.

Ques.—What were the current density requirements and current distribution in the experimental Baton Rouge installation?

Ans.'—When the initial, experimental installation was designed only meager data were available for a protective system of this type and showed that protection had been attained with current densities anywhere from 1 to 8 ma. per sq. ft. No water analyses were correlated with these data. Design was made on the basis of a total current capacity of 50 amp., or an average of 6.6 ma. per sq. ft. for protection of the coils and box, in the experimental installation.

Ques.—What rectifier equipment was selected for the Baton Rouge installations?

Ans.'—A standard copper oxide oil-immersed unit rated at 15 volts and 100 amp. maximum d.c. output was selected for the first (experimental) installation, making sufficient capacity available for protection of a similar cooler coil and box located adjacent to the one under protection.

For protection installed subsequently on two additional coolers, a standard selenium oil-immersed rectifier rated at 75 amp. and 12 volts d.c. output was specified.

Ques.—How were the anode systems designed?

Ans.'—For the initial experimental installation a total of 104 flat steel-plate anodes were installed as shown in Fig. 4. Each anode was made of $\frac{3}{8}$-in. plate 12 in. wide and $10\frac{1}{2}$ ft. long extending to within 6 in. of the bottom. Center-to-center spacing of 30 in. was maintained where possible.

For the later installation, based on experience obtained with the experimental unit, a total of 189 cylindrical units were used, spaced closer together (at 16-in. centers) to give better distribution of current (Fig. 5).

Ques.—What are some features of the electrical system?

Ans.'—The electrical system (Fig. 6) consisted of d.c. leads designed to permit only a negligible voltage drop so that the rectifier voltage required could be held to a minimum. Current from the rectifier was supplied to bus bar, and from these to the anodes. Current was drained from each vertical bank of tubes to a main drain lead which also drained the box well. The system was designed to provide electrical symmetry in both the anode and drain leads. All copper-to-steel connections were made by brazing.

Ques.—What conclusions can be drawn after 2 years of experimentation on cathodic protection of open-box coolers?

Ans.'—1. It is an effective means of controlling corrosion on the complex structures of open-box-type coolers.

2. Economically, cathodic protection can be justified because it eliminates necessity for replacement of corroded equipment, reduces cost of maintenance repairs, or both.

3. Sufficient current density must be maintained to assure protection throughout the system and a large anode system with relatively close spacing between anodes is necessary to distribute current equally.

4. Average current density of 10 ma. per sq. ft. is recommended.

5. Protection criterion used to determine the degree of protection in these installations has not been definitely established.

Materials Used to Fight Corrosion

1. Clad Steels

Ques.—What are some important metals used in cladding?

Ans.[10]—Important clad metals are:

1. Nonferrous: nickel, Inconel, monel, copper.

2. Straight chromium steels: (11.50 to 18 per cent chromium).

3. Chromium nickel steels: (16.0 to 26.0 per cent chromium and 6.0 to 22.0 per cent nickel. Titanium, colombium, and molybdenum may also be present).

Ques.—How are clad steels made?

Ans.[10]—Clad steels as manufactured by one company consist of a light layer of corrosion-resistant metal—nickel, stainless, Inconel or monel—permanently bonded to a heavier

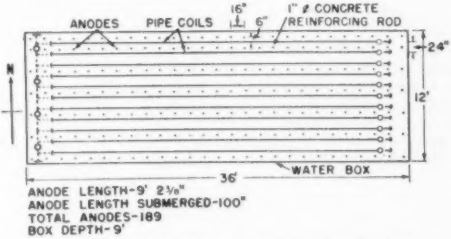


Fig. 5—Anode spacing in second installation.

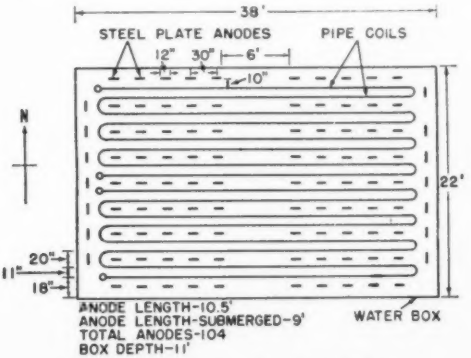


Fig. 4—Initial cooler box installation.

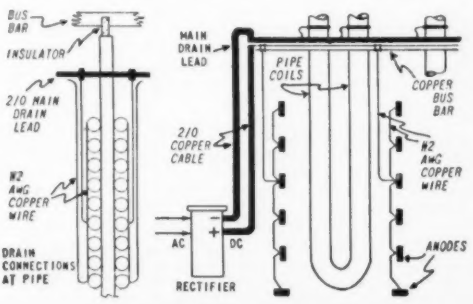


Fig. 6—Details of electrical system.

backing plate of A.S.M.E. specification steel. Clad steels are normally furnished with the clad thickness equal to 10 per cent of the total plate thickness. However, the clad thickness may be varied to suit operating or fabricating conditions in the range from 5 to 50 per cent.

Ques.—What are some applications of clad steels in the refining industry?

Ans.[10]—Nickel-clad steel is used for pressure vessels, tube sheets, and storage tanks for caustic soda solutions. Stainless-clad steels are used for a wide variety of petroleum equipment where stainless is particularly resistant to corrosive attack. Inconel-clad steel has been used in condensers, heat exchangers, and for equipment operating at higher temperatures and handling streams with hydrochloric acid content. Monel-clad steel is used to withstand corrosive acids in the top sections of fractionating towers in the hydrofluoric acid alkylation process.

2. Chromate Inhibition

Ques.—Even when condensers and other heat-transfer equipment are constructed of corrosion-resistant material, is it desirable to use chromate inhibitor?

Ans.[11]—It is desirable, since the external piping and pumps which circulate the water are made almost universally of iron and steel, and chromate is required to inhibit corrosion of these parts. Also the chromate increases the life of parts made from corrosion-resistant metals such as bronze, nickel, stainless steel, copper, monel, brass, tin, and lead.

Ques.—Does aeration affect efficiency of chromate?

Ans.—Water which courses through cooling towers or spray washers is saturated with atmospheric oxygen. Unless chromate is present, this aeration creates a condition which may result in accelerated attack. Laboratory and field trials have shown that the efficiency of chromate is unaffected by aeration because chromates are oxidants which passivate through a mechanism known as anodic polarization, an electrochemical process presumably due to formation of an insulating layer of oxygen on the surface of the metal. Later this inhibition is reinforced with a layer of metal oxide.

Ques.—What have been the development results of chromate in paints?

Ans.[11]—As a result of intensified wartime research, the outstanding merit of zinc yellow (basic potassium zinc chromate, $K_2O.4ZnO.4CrO_3.3H_2O$) has been demonstrated by its wide use on aircraft and naval vessels. It is unexcelled as an inhibitive pigment for equipment or structures fabricated from iron, steel, aluminum, and many other metals. Other chromate-containing inhibitive pigments are in various stages of development.

Ques.—What are these inhibitive pigments now being developed?

Ans.[11]—These include complex chromates of the alkaline-earth metals. At the present time, practically all paint manufacturers are prepared to supply zinc chromate inhibitive paints ready to apply by brush, spray, or dip. For the most part these paints contain, in addition to a chromate pigment, smaller proportions of iron oxide and magnesium silicate which appear to be beneficial. The vehicle generally used is of the alkyd type thinned with petroleum distillate.

Ques.—What is the composition of chromate-containing paints used for protection of refinery equipment and structures?

Ans.[11]—Practically all yellow paints are made from lead chromate; greens are mixtures of lead chromate with a blue pigment; oranges are made from basic lead chromate. Heat-resistant and weatherproof green pigments and roofing granules of the best quality are made by firing ceramic materials with chromic oxide. Before painting, it is often advantageous to passivate metal surfaces with a chromic acid or bichromate dip. Some treatments produce a protective chromate conversion film.

3. Protective Coatings

Ques.—What are properties of vinyl resins that may be used as protective coatings?

Ans.[12]—Vinyl films are noninflammable, have low water absorption, and low moisture vapor transmission rate. The major limitation of vinyl coatings in a refinery is their resistance to continued high temperature. Except where specially formulated, vinyl resin coatings are not satisfactory for temperatures above 180° F. They have high resistance to acids, alkalis, chemical solutions, and petroleum hydrocarbons.

Ques.—Can vinyl films be used as coatings for immersion conditions?

Ans.[12]—For immersion conditions, tank linings, and similar exposures effective full use of a vinyl coating can be made by using a "system" coating which consists of prime, intermediate, and final coats.

Ques.—What sort of surface preparation is required?

Ans.[12]—A perfectly clean, dry metal or concrete surface is a basic requirement. A sandblasted surface is best; acid pickling comes next but this is ordinarily restricted to new work. Power sanders may be used or chipping and wire-brushing may also be used but these are not as desirable methods as sandblasting.

Ques.—How may vinyl coatings be applied?

Ans.[12]—They are applied by standard paint equipment. They may be brushed or sprayed without difficulty but more care must be exercised in applying vinyl coatings than is used with conventional paint.

Ques.—What are some examples of refinery equipment for which vinyl coatings have been used?

Ans.[12]—Vinyl resin coatings have been used for a variety of equipment, including: exterior of caustic tanks, interior of lead-lined gasoline treaters, gas area on interior of floating-roof tanks and interior of pan tanks subject to sour crude and raw gasoline, interior of acid sludge tanks, interior of pipe lines subject to treating liquids, and interior of concrete pipes for refinery sewers.

Ques.—What are some factors involved in selection of paints for use in the petroleum industry?

Ans.[13]—Some uses of paint involve merit for sanitation, cleanliness, or advertising value. Some requirements necessitate resistance to atmospheric conditions, acids, alkali, gasoline, oils, solvents, water, abrasion, mildew, heat, or flame. In some cases, paints are used for identification, prevention of contamination by iron, for luminous properties, for repelling insects, or as antifouling paints to reduce fouling by marine organisms.

Ques.—How may surfaces be prepared for painting?

Ans.[13]—The surfaces should be properly prepared so they will be clean, dry, and free from any impurities detrimental to the paint. Frequently this is not given the proper attention and, as a result, more costly cleaning is necessary in repainting. If time will permit, new steel should be weathered to remove mill scale.

1. Sand or grit blasting is recognized as the best method of surface preparation. To eliminate the dust and silicosis hazard in sandblasting, vacuum equipment is available and wet or vapor blasting methods with rust inhibitors have been developed.

2. Phosphoric acid pickling and priming at the mill and some phosphoric passivating washes have been tried out. The phosphoric treatment must be followed within a few hours by the paint primer. For many purposes, their additional cost has not appeared to be justified. They do have merit in shop painting of curb pumps, oil-burning equipment, steel sash, refrigerators, and other similar equipment. Phosphoric washes and wash primers are used in the Navy on the bottoms of ships after wet sandblasting.

3. Flame cleaning or descaling is one of the newer methods which has merit particularly for waterfront or damp locations where there is no

safety hazard due to explosive vapors. It requires subsequent scraping and wire brushing, but leaves the surface in a warm, dry condition favorable for good paint adhesion.

4. Mechanical rotary or manual wire brushing after scraping is by far the least expensive method of cleaning. After about 6 months' weathering and loosening of the remaining mill scale by application of a distillate oil, effective cleaning can be accomplished by this method on outdoor surfaces.

5. For galvanized iron, instead of the old-type etching treatments, successful results are obtained by removing oil or grease with a naphtha solvent and applying a zinc dust primer.

6. Alkaline concrete or plaster surfaces must be neutralized with zinc sulfate or weak acid to prevent saponification of oil-base paints. On all absorptive surfaces a primer sealer must be applied. Asphalt or bituminous surfaces require a special sealing paint to prevent bleeding of the asphalt or coal tar into the finish.

Ques.—What are some considerations with regard to primers?

Ans.[10]—Of the various types of primer such as red lead, blue lead, zinc dust, chromates, iron oxide, and others, a red lead-and-oxide primer has proven to be a good general-purpose primer for steel. This has been shown in service tests and experiences for more than 20 years under different finishes and various climatic conditions. About 25 years ago, it replaced the old-type graphite-and-carbon black linseed-oil primers which sometimes stimulated corrosion and deep pitting in the presence of salt moisture, acidic condensate, or other electrolyte. The red lead-and-oxide primer with a minimum of 50 per cent red lead in the pigment has rust-inhibitive properties as well as outstanding brushing, drying, and adhesion.

2. In more corrosive locations such as warm seacoast areas, it is considered good practice to supply two priming coats to reduce cost of cleaning in repainting. Two different colored primers have been used to assure complete coverage by each coat.

3. Zinc chromate primers complying with federal specifications are recognized as having excellent rust-inhibitive properties. Although both the slow and fast-dry types are being investigated, they have not proven to be superior to the red lead-and-oxide primer in durability. Zinc chromate primers have more water-soluble constituents than the red lead and may give a thinner, less durable film.

4. For sea-water or marine atmospheres, on barges, tankers, or other equipment requiring a quick-drying, tough coating, a zinc chromate-and-iron oxide bakelite primer can be used to advantage. Other alternates are the alkyd red lead primers or a red lead-and-oxide primer with the addition of 1 lb. of litharge to each gallon. For contact with water, at least two coats of such a primer should be applied.

5. For one-coat protection of steel during storage, iron oxide paints have shown the best durability. These paints may be used for both priming and finishing.

Ques.—How about tank-finishing paints?

Ans.[12]—Aluminum paints show very good resistance to chalking and fumes and in many cases good protection for 10 to 15 years without repainting. Present-day paste-aluminum paints surpass the earlier coarser, powder-aluminum paints. They have been used extensively for bulk-station tanks and light-gravity refinery tanks.

For roofs of tanks containing light-gravity products subject to evaporation losses, white paints which stay white will keep the vapor space as much as 9° F. cooler than an aluminum-painted roof. The present practice is to use a durable product, an alkyd, titanium oxide, fumeproof white finish. This paint should be applied in two coats over a suitable primer and may be used with an aluminum intermediate coat to improve durability.

To make soiling less conspicuous and to serve as a low-cost finish, black-graphite finishes for the bottom rings of tanks have given excellent protection with a waterproofing of fibrated asphalt for about 12 in. at the base. To prevent discoloration by a sulfurous atmosphere, finishing paints used in refineries must be free from lead compounds.

A special type of protection has been used for gas-holder lifts. Automatic painting with black oil has given good protection as the lift raises up and down through the cup of oil. This was recognized as a good practice more than 10 years ago in locations where appearance is not objectionable.

Ques.—What measures may be taken for protection of underground tanks and underside of tank bottoms?

Ans.[11]—Heavy applications of cutback steam-distilled asphalt have given good protection for underside of tank bottoms. If bottoms have not been adequately protected as in welded construction, cathodic protection has been used where corrosive conditions exist.

The exterior surface of steel underground tanks may be protected by a heavy asphalt coating over an inhibitive primer. In salt-water locations sacrificial magnesium anodes are being tried out to supplement the protection by the coatings.

Ques.—What is the status of coatings for tank interiors?

Ans.[11]—Service tests are under way in sour-stock tankage, gasoline tanks in salt atmospheres, tank trucks, tank cars, and miscellaneous tankage where internal corrosion is experienced.

Inside the shell of floating-roof tanks in gasoline service, good protection has been obtained from two coats of a bakelite aluminum paint over two coats of a bakelite zinc chromate-and-iron oxide primer.

Inside aviation-gasoline truck tanks, two coats of pigmented shellac-base paint have given good protection for about 2 years and have kept rust out of meters. Three coats of pigmented latex-vinyl paint have shown greater durability at a higher cost which may be justified in locations where internal corrosion is experienced.

During the past few years various manufacturers have proposed the use of vinyl paints for protection inside tanks handling sour stocks, gasoline, or other petroleum products where corrosion is being experienced. To assure a good bond, sand or grit blasting is necessary. There are a number of air-drying vinyl copolymer and other vinyl plastic paints for protection against corrosion for temperatures up to about 150° F. Some are claimed to have given 2 to 3 years' complete protection inside sour-stock receiving tanks. Because of low nonvolatile content, they require about four to six double coats with a minimum film thickness of 0.006 in. To assure complete coverage, it is desirable to alternate the color of each successive coat.

For inside sour-stock equipment, vinyl paints show some promise but may be less satisfactory than gunite. Oil-resistant coal-tar paints are also being considered for such service. Various types are available including those for hot application, some fibrated, and others emulsified. All require heavy application to assure best results.

Phenolic paints, air dried or, even better, heat hardened if baking facilities are available, also have merit as interior tank coatings.

Ques.—What use has been made of heat-hardened bakelite and other phenolic coatings?

Ans.[11]—These have shown good resistance to sea water, gasoline, solvents, acids, weak alkali, abrasions, impact, and temperatures up to about 300° F. If practicable, equipment should be coated before shipment.

These coatings have been used as substitutes for galvanizing. They have been applied for protection of aviation-gasoline drums, catalyst drums, hot-water tanks. They are not satisfactory to resist higher concentrations of alkali. They are more expensive than the air-drying vinyl coatings but may be more durable for some condi-

tions where baked-on coatings are practical.

Ques.—What treatment may be applied to protect against corrosion of steel in back of concrete, gunite, or brick?

Ans.[17]—All such fireproofing should be adequately waterproofed with two coats of an emulsified asphalt or coal tar which may be applied over a damp surface or a fibrated asphalt on a fairly dry surface. As a further precaution to prevent corrosion in corrosive locations, the steel should be coated with asphalt, galvanizing, or other suitable coating before fireproofing with brick. Normally gunite or rich concrete are sufficiently dense and impervious to assure good protection by themselves and will have a better bond to the steel without a coating. In cases of cracks or porous material in corrosive locations, adequate exterior waterproofing should be applied.

Under insulation of steel where temperatures are less than 200° F. and not sufficient to drive off mojsture, a ⅛-in.-thick waterproof barrier is recommended between the steel and the insulation.

Ques.—What heat-resisting paints may be used?

Ans.[18]—Various tests have been made on heat-resisting paints for stacks, breechings, heat exchangers, exhaust pipes, mufflers, boiler fronts, and other hot surfaces. The outside temperature at the lower part of the stacks may be reduced by internal insulation.

For temperatures up to 900° F., good protection can be obtained from a zinc-dust gray paint in one coat directly over clean, dry steel. When the vehicle burns off, the zinc pigment fuses into an alloying coating on the steel so that some continued protection is obtained.

Other heat-resisting paints available for lower temperatures consist of coal-tar black with ceramic frets for temperatures from 400° to 650° F., alkyd aluminum paint for exterior surfaces up to 600° F., and gilsonite black for temperatures up to 500° F. Some black or aluminum paints, made with ceramic frets, are claimed to withstand temperatures up to 1,000° F.

Applications—Equipment and Environment

1. Handling Sour Crude

Ques.—What corrosion problems are primarily peculiar to the refining industry?

Ans.[19]—Those which arise as a result of the presence of corrosive sulfur compounds and of chlorides of magnesium and calcium in the crude oils. The major offenders in this respect are the high-sulfur crudes, frequently referred to as sour crudes, which include West Texas and Panhandle.

Ques.—What are factors in low-temperature (under 500° F.) corosion?

Ans.[20]—Low-temperature corrosion encountered in processing sour crudes is primarily due to hydrogen sulfide, hydrochloric acid, water, oxygen, and carbon dioxide. Presence of water is considered necessary for any appreciable corrosion to occur in processing sour crudes at low temperatures.

Qpes.—What are factors in high-temperature (above 500° F) corrosion?

Ans.[21]—Corrosion of this type is primarily due to sulfur compounds present in the crude oil. Presence of inorganic salts, particularly chlorides of calcium and magnesium, may have a marked effect upon the rate of corrosion experienced. . . Of the various sulfur compounds present in sour crudes, it is generally agreed that free sulfur, hydrogen sulfide, and mercaptans are the most corrosive under high-temperature conditions.

Ques.—What are some of the means that may be employed to increase life of tanks which handle sour crude?

Ans.[22]—Heavier steel construction, roofs of aluminum and galvanized steel, caustic washing, flat roofs in crude service, protective coatings, and gunite linings. One of the most effective low-cost methods of increasing the life of a tank is to increase thickness of the steel plates.

Ques.—How do you protect lines in sour-crude and distillate service?

Ans.[23]—It is not general practice to protect lines in sour-crude and distillate services, although it is recognized that they are subject to all the corrosive conditions that usually affect tanks in similar services, except that possibly less air is present in the lines. However, in some isolated cases ammonia or caustic solution may be injected into distillate lines to reduce corrosion. In those cases the corrosion is usually due to an inorganic acid, such as hydrochloric acid, rather than to compounds of sulfur.

Ques.—How does sour crude affect distillation equipment?

Ans.[24]—Based on the experience obtained in reducing West Texas crude to about 40 per cent bottoms in a pipe still, the corrosion parallels that experienced in other distillation operations in which sour crude constitutes the charge. . . Rapid corrosion was experienced in the furnace tubes and overhead lines and condensers. All the original tubes in the furnace of this pipe still were of low-carbon steel. Rapid corrosion of these tubes was experienced, necessitating replacements after 4 to 6 months.

Ques.—In this particular pipe-still installation, running West Texas crude, what were the steps taken to reduce corrosion in furnace tubes?

Ans.[25]—First step in reducing this corrosion consisted of introducing caustic with the crude charge. It was found that caustic solution equivalent to 6 lb. of sodium hydroxide per 1,000 bbl. of crude oil could be injected with the charge without affecting the operation of the pipe still or of the residuum cracking units. This quantity of caustic reduced the corrosion of the furnace tubes, but replacements of tubes near the coil outlet was necessary after 6 to 8 months.

Larger amounts of caustic progressively reduced furnace-tube corrosion at the pipe still, but limited operations at the residuum cracking units because of the rise in tube-metal temperature of the cracking-coil furnace tubes. As a result of this, caustic solution equivalent to 6 lb. per 1,000 bbl. of charge was injected with the crude charge, and 20 steel tubes at the coil outlet were replaced with 4 to 6 per cent chromium-0.5 per cent molybdenum tubes.

This combination of injecting caustic with the crude charge and using 4 to 6 per cent chromium tubes near the furnace outlet has controlled satisfactorily the corrosion of the furnace tubes.

Ques.—How is ammonia used to control corrosion in a pipe still operating on sour crude?

Ans.[27]—Ammonia is injected into the vapor lines upstream from the coil-in-box condensers to control the corrosion of this equipment. Frequently, ammonia is injected upstream from exchangers that are equipped with copper-bearing alloy tubes. Admiralty metal under stress, (in one case) failed as a result of stress-corrosion cracking in an atmosphere containing ammonia, moisture, and oxygen after 3 hours of exposure.

Ques.—How is stress-corrosion cracking, caused by ammonia, remedied?

Ans.[28]—By adding 3.0 per cent by weight of butyl mercaptan . . . to the ammonium-hydroxide solution over which the stressed admiralty metal was suspended. After 194 hours of exposure, there was no evidence of failure as a result of stress-corrosion cracking. Equally good results were obtained with hydrogen sulfide and carbon disulfide.

Ques.—What, in general, has been the experience with 18-8 alloy tubes in thermal cracking furnace service?

Ans.[29]—In general, the performance of 18-8 alloy tubes in this type of

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cracking operation has been satisfactory. Many of the original tubes are still in service after more than 100,000 hours of operation. During this period some tubes have failed, whereas others have undergone some rather marked changes in their physical properties.

On the basis of certain examinations, it has been postulated that the deterioration and, possibly, the failure of the 18-8 alloy tubes are due to structural changes at the grain boundaries. These changes are believed to be progressive in nature, and are dependent upon time, temperature, and stress.

Ques.—How do you eliminate corrosion in lines through which sour crude oil is pumped at a temperature above abcut 450° to 500° F.?

Ans.[24]—To eliminate this type of corrosion, essentially all of the lines downstream from the furnace were replaced with 18-8 alloy lines. The installation of 18-8 alloy lines in hot-oil service has essentially eliminated corrosion in this service.

Ques.—How can you protect soaking drums, separators, bubble towers, and accumulators from corrosion by sour crude?

Ans.[24]—A soaking drum of low-carbon steel can be protected against corrosion by application of a reinforced layer of gunite about 3 in. in thickness. This type of protection is very effective in shielding the drum but coating is frequently damaged in process of removing coke, necessitating regular repairs or replacement of the gunite coating.

Separators of all-steel construction can be treated by guniting the shell, with installation of an 18-8 alloy lining in manhole openings, etc. Steel plates in the separator can be replaced with 4 to 6 per cent chromium steel as they fail. All supports are of 18-8 alloy.

Bubble towers of low-carbon steel are equipped with steel plates and cast-iron bell caps except for the three bottom plates in the primary bubble tower which are of 11 to 13 per cent chromium steel with bell caps of the same material. Shell of the primary tower should be protected with a gunite lining.

Ques.—How does sour crude affect catalytic cracking units?

Ans.[24]—Corrosion, as such, is not a problem of any particular significance in the operation of fluid catalyst cracking units. Some difficulty is experienced as a result of erosion of certain portions of the equipment. One case of corrosion occurred in the 18-8 alloy vapor lines leading to and from the reactor on an upflow unit, and was intergranular in nature.

". . . The vapor line in which (this) stress - corrosion cracking occurred were lined at points of turbulence with carbon-steel wear plates to absorb erosion caused by the catalyst. The intergranular cracks that occurred in these vapor lines were located behind the carbon-steel wear plates. The extent of this type of corrosion was such that it made the unit essentially inoperable."

Ques.—How was this corrosion problem approached?

Ans.[24]—As a result of extensive research work the carbon-steel wear plates were removed from all 18-8 alloy tubes and vessels in the catalyst system, and wear plates of 18-8 alloy were installed. This eliminated the formation of iron sulfide between the wear plates and the 18-8 alloy lines and, as a result, eliminated the intergranular corrosion of the 18-8 alloy lines and vessels.

Ques.—Is all corrosion experienced in cracking operations at elevated temperatures due to sulfur or its compounds?

Ans.[24]—Not necessarily. There are cases, in fact, in which appreciable quantities of sulfur are extremely effective in reducing corrosion of 18-8 alloy furnace tubes in high-temperature cracking service. In butadiene plants during World War II, using the true-vapor-phase process, a peculiar and acute type of corrosion was experienced which resulted in failure of the 304-type 18-8 alloy tubes in the naphtha circuit of the superheater furnace after only 120 hours of operation. Similar corrosion was experienced at two other plants.

In initial stages of reforming sweet naphtha from Refugio crude at one of these plants the unit was rendered inoperable because of the rapid corrosion of the 18-8 alloy furnace tubes in the naphtha circuit. After extensive tests, it was indicated that metal temperature was an important factor in the corrosion.

Ques.—What counteracted corrosion by the naphtha?

Ans.[24]—Laboratory tests proved that carbon dioxide, ethyl alcohol, acetic acid, hydrogen sulfide, and sulfur dioxide are satisfactory inhibitors for controlling the type of corrosion experienced in the butadiene plant.

Ques.—What is the major contributing factor in failure of relief valves in sour-crude service?

Ans.[25]—In one instance, shortly after the startup of a vapor-recovery unit, considerable difficulty was encountered with the breaking of carbon-steel relief-valve springs. It was found that the failures of the springs were due primarily to hydrogen embrittlement. It became evident that eliminating this reaction of $Fe + H_2S \rightarrow FeS + 2H$ would put a stop to the spring failures. In this particular instance the carbon-steel springs were replaced with springs which had been metalized with aluminum. No failures occurred in approximately 3 years.

Ques.—Is there any permanent way to make springs resistant to corrosion?

Ans.[25]—Yes. A spring manufactured from one of the 18 per cent chromium 8 per cent nickel steels would have been suitable and more permanent than an aluminum coating, inasmuch as the coating can become damaged or flake off, thus exposing the spring to corrosion again.

Ques.—Which is the more serious, corrosion of the disk guide of a relief valve, or of the relief-valve springs?

Ans.[27]—From a safety standpoint, corrosion of the disk guide is more serious . . for the reason that the corrosion product formed on the surface of the guide, and in the small clearance between the disk and disk guide, restricts the movement of the disk and prevents the valve from functioning properly.

Ques.—How can the problem of corrosion of the disk guide be met?

Ans.[27]—To meet this problem, inside surfaces of a number of disk guides can be electroplated with hard chromium.

Ques.—Why is chromium selected?

Ans.[27]—Chromium plate is selected because it offers an immediate solution. Hard chromium plate has previously indicated ability to resist hydrogen sulfide corrosion, and it appears to be especially desirable as a relief-valve material because of its low coefficient of friction.

2. Handling Acid Sludges

Ques.—What is particularly troublesome in handling of sulfuric acid and acid sludges?

Ans.[29]—Low - temperature strong acid is not particularly troublesome, but acid below 60 per cent by weight is extremely difficult to handle. A variety of materials is offered by manufacturers each of which has its economic position somewhere in the wide range of conditions encountered. Lead is probably the most universal material used to retain weak sulfuric acid but its physical characteristics are such that additional support is required.

Ques.—What has been the experience with pipe handling acids and sludge?

Ans.[29]—Expensive repairs and replacements have been associated with the all-lead installation. Steel pipe with bonded lead lining did not prove satisfactory.

Ques.—What other means may be taken to eliminate expensive replacements?

Ans.[*]—Three possible means are:

1. Reduce temperature of weak acid so lead or brass will be satisfactory.

2. Provide materials of construction such as glass, ceramics, tantalum, etc., which will resist weak acid at elevated temperature.

3. Provide combinations of materials such as bonded lead pipe with Karbate sleeves.

The third of these was considered the most promising. A considerable amount of lead lined-Karbate lined pipe had been installed at the time of writing. It was hoped that this experimental installation would prove satisfactory, although quite expensive.

3. Tank Corrosion—Under Bottom[14]*

Ques.—How is corrosion of exterior tank bottoms caused?

Ans.—This corrosion is caused by stray currents or by galvanic action. Stray currents usually enter tanks through connecting lines which pick up and carry such currents from nearby power lines, electric railways, or from long line currents, believed picked up from the earth's magnetic field. Galvanic currents are set up between various parts of the tank bottom by a difference in metal composition, damaged paint films, or varying soil conditions.

Ques.—How may stray currents be reduced or eliminated?

Ans.—Stray currents can usually be reduced or eliminated by installing insulating flanges on all entering lines and periodically checking their efficiency. If this is not possible, rectifiers or anodes may be used to impress a sufficient current on the tank to prevent corrosion.

Galvanic currents, generated in the tank bottom itself, may be controlled by using a proper fill below the tank. Cinders and shell are particularly undesirable, while clean fresh-water sand is generally satisfactory. A dry, well-drained foundation also is most desirable.

The only way to be sure corrosion is not taking place is to run a survey to determine how much current is leaving the tank through its bottom. Simple instrumentation for this purpose is now available. If more than 0.01 amp. is being lost, many companies take steps to rectify the condition. Several buried magnesium or zinc anodes of proper size will render the tank bottom cathodic and therefore protect it. Anode life may be controlled to 8-10 years by placing sufficient resistance in the circuit. A 17-lb. magnesium anode, at 0.5 amp. per year, will last 10 years. Similarly, rectifiers may be used for cathodic protection and often scrap iron, junk pipe, or other buried metal may be used as the expendable anode. Today, a trained electrolysis engineer can readily predict and almost completely eliminate tank-bottom corrosion.

[*]Original material from The Texas Co specially prepared for this report.

4. Tank Corrosion—Interior[14]*

Ques.—What are some problems in connection with interior tank corrosion?

Ans.—1. Hydrogen sulfide is an acid. When present with water, it ionizes and combines with a metal, such as iron, to form iron sulfide, with hydrogen usually being given off. Hydrogen sulfide presents a serious problem because the nascent hydrogen coming off in the reaction between the metal and acids is able to penetrate into the interior of the metal at the points where corrosion is occurring.

2. In tanks hydrogen goes into the metal (according to the literature), and runs into a barrier. The nascent hydrogen changes to molecular hydrogen and begins to collect at some point inside the metal wall of the tank, under fairly high pressure. At times the pressure is sufficient to cause the metal to separate and blisters will appear on the tank sides. The internal pressure developed in the blister sometimes becomes so high that a rupture of the vessel wall results.

3. In the case of tanks using steel decks, the iron sulfide formed on the lower side of the deck will build up a certain thickness and periodically flake off and drop to the bottom of the tank. Iron sulfide is cathodic to ordinary iron and a galvanic cell is set up between iron sulfide on the bottom of the tank and iron underneath, causing holes to be eaten in the iron bottom.

4. Another factor causing tanks to corrode is the presence of brine or salt water on the tank bottom and has proved to be one of the major reasons for tanks failing in sweet or sour crude service.

Ques.—What methods are used to combat corrosion on tank interiors?

Ans.—The inhibitors which are useful in preventing well corrosion are also very effective in stopping sour-crude corrosion. Where these inhibitors are used in connection with producing wells, there is sufficient inhibitor left over to coat the tanks, which seems to make them last much longer.

Several coatings are used on the interiors of tanks to prevent corrosion. Of these gunite is about the most efficient and most expensive. Where the application is performed properly, gunite will last for many years. However, in field use, gunite will add much to the weight of a tank with the result that it is no longer possible to move it from one lease to another.

Other types of coating have been tried in the field on tanks. It is impractical to apply baked coating in the field, but various air drying types have been used. The vinyls, mixtures of vinyl chloride and vinyl acetate of various proportions and rubber, both plain and chlorinated have been used. One has recently been prepared of a mixture of furfural and furfural alcohol, which seems to have some promise.

These so-called plastic coatings fail, generally, in a period of 2 years depending on the severity of field service. Some of the coating users believe that poor application is the major factor. In any case, the coatings are porous and it is possible for moisture to penetrate through the coating itself, unless one proposes to keep out the moisture with a thick film. The thin film of 6 mils being used will not keep out moisture. As soon as the moisture gets in it will react with the tank with spalling of the coating and continuance of corrosion.

While galvanizing has been used on tanks it does not seem to provide much protection for tanks in sour crude service and is very expensive. It has been found, however, that the addition of a small amount of aluminum and magnesium to the zinc of the galvanizing solution will give better resistance toward sour crude.

For tank decks, deck rafters, and top rings aluminum appears to give very good service. There can, however, be no contact with brine or alkali of any type.

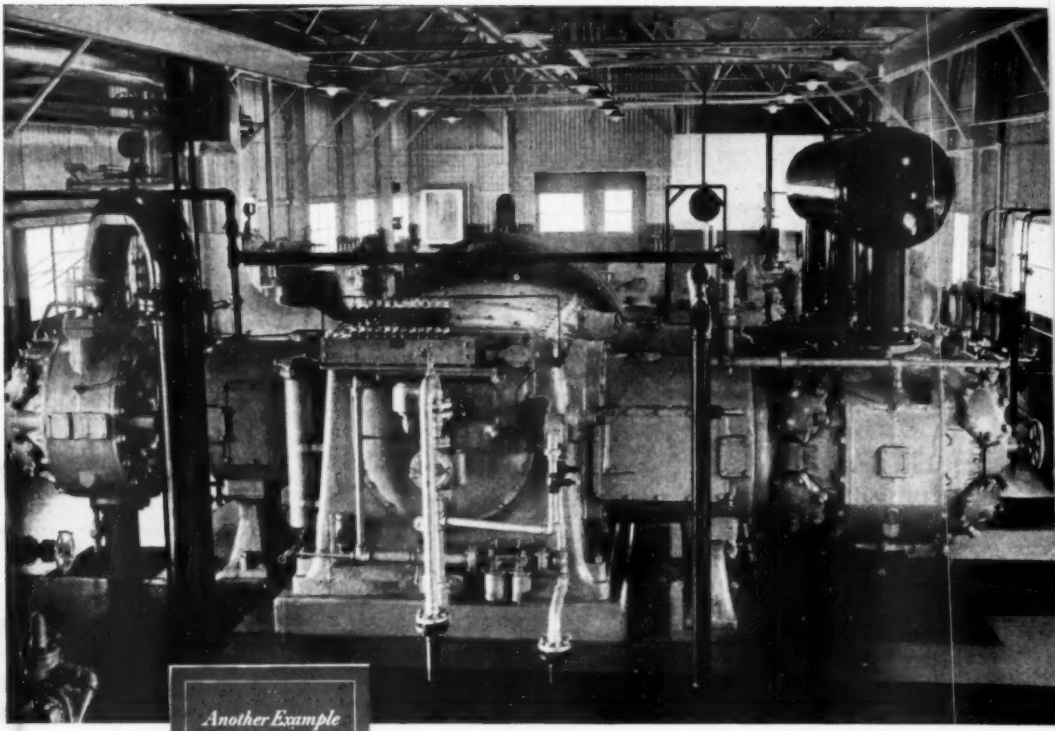
Cathodic protection has been applied on the interiors of tanks. By installing sufficient anodes, or a rectifier, with some sacrificial metal to provide current, the insides of these vessels can be protected from corrosion as long as desired. The unfortunate thing is that it usually costs more to protect than to replace. In the bottom of tanks, generally there is not sufficient water to provide good electrical contact for the installation of the anode.

Ammonia has been used, particularly in tanks. It is introduced into the vapor space and seems to form an inhibitor which prevents corrosion in that area.

[*]Original material from The Texas Co specially prepared for this report.

5. Storage Tanks—Ammonia Injection

Ques.—Ammonia injection to control corrosion in process units when handling sour crudes is not new. However, a paper by Gardner et al[*]



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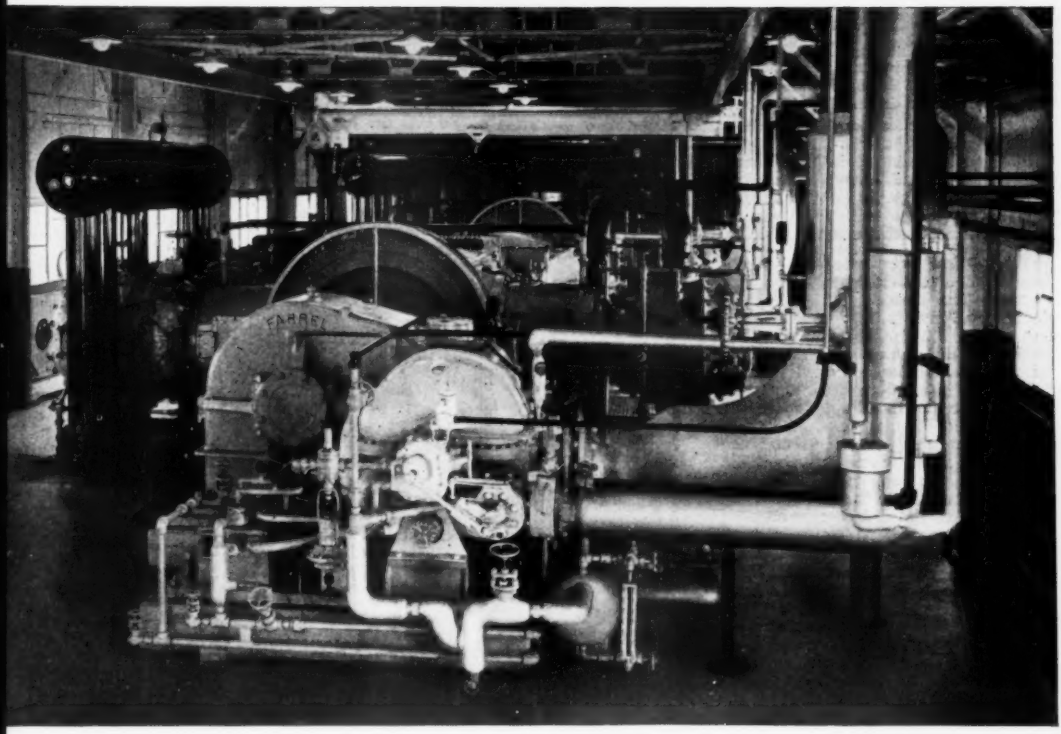

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has described ammonia injection to storage tanks. What are some of the factors involved in this application?

Ans.[5]—Production of sour crude (that containing dissolved hydrogen sulfide) has been increasing. Sometimes sweet and sour crudes are blended in storage. As a result severe damage to storage tanks from vapor-zone corrosion had increased rapidly.

Ques.—How was ammonia injection applied in field tests?

Ans.[5]—The method of application is indicated in Figs. 7 and 8. The layout of Fig. 7 is for injection to large tanks in the tank farm. A single measuring chamber equipped with a sight glass is used to determine, by volume, the amount of ammonia used in treatment. Liquid ammonia is expelled from this chamber into the expansion tank, where it vaporizes and travels through a ¾-in. black iron pipe directly to the storage tank being treated. Galvanized pipe should not be used.

Fig. 8 shows another installation for injection of ammonia using 150-lb. ammonia cylinders. A volumetric measuring container, calibrated in pounds of ammonia, is provided for each tank. Expansion chambers have been eliminated. Treatment is applied when the temperature is on the way down or when tanks are being pumped out.

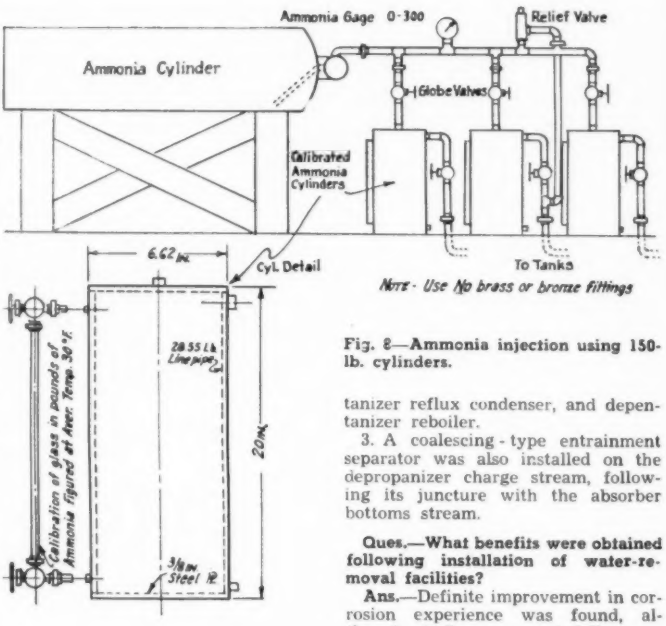

Fig. 8—Ammonia injection using 150-lb. cylinders.

6. Water Removal[7]

Ques.—In a recent A.P.I. report[7] concerning corrosion in a T.C.C. gas plant, it was found that the corrosion was closely associated with the presence of water. What steps were taken to prevent or minimize corrosion under these conditions?

Ans.—Preventive measures consisted of water-removal facilities installed at three points:

1. A flood nipple was installed in the bottom of the absorber tower and manual water withdrawal was established every 4 hours. The purpose of this was to lessen the load on the entrainment separator placed further downstream.

2. A coalescing-type entrainment separator was installed on the depentanizer-feed gasoline stream. This separator was simply a small vessel containing excelsior and with a small leg for the purpose of trapping the separated water. Water separation was provided here to give corrosion-protection for the depentanizer charge-bottoms exchanger, depentanizer reflux condenser, and depentanizer reboiler.

3. A coalescing-type entrainment separator was also installed on the depropanizer charge stream, following its juncture with the absorber bottoms stream.

Ques.—What benefits were obtained following installation of water-removal facilities?

Ans.—Definite improvement in corrosion experience was found, although studies were not fully completed at the time of publication of this report. Unexpected benefits were obtained in reduction of caustic consumption at the gas plant (excess water had formerly diluted the caustic) and better operation of both depropanizer and debutanizer towers.

Ques.—What special corrosion problem had been encountered with reboilers prior to installation of water-removal facilities?

Ans.—Debutanizer reboiler tube

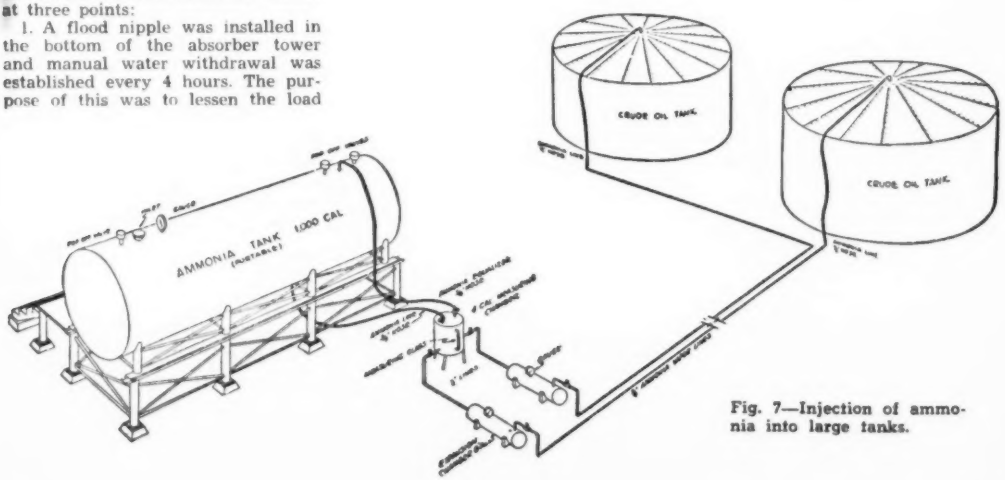

Fig. 7—Injection of ammonia into large tanks.

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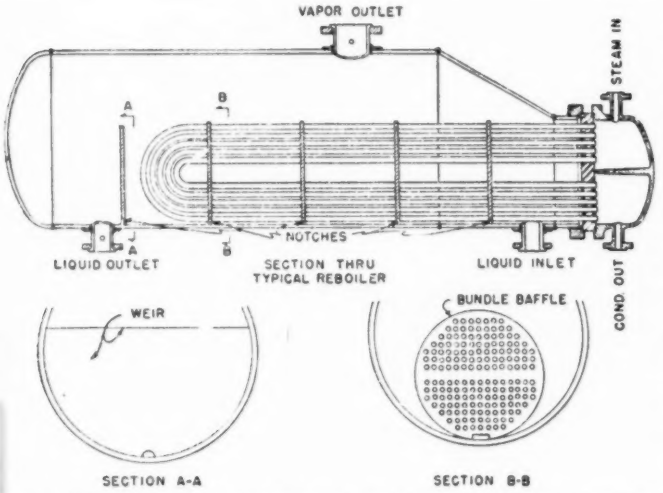


Fig. 9—Notching bottoms of tube-bundle baffle plates minimized corrosion.

failure was connected with iron sulfide sludge which had lodged at the bottom of the reboiler bundle. To reduce this corrosion, the sludge factor was reduced by notching the bottoms of baffle plates of the tube bundle, and by enlarging the weep hole of the weir plate in the reboiler to encourage more thorough drainage of water and sludge to the bottom process outlet connection (Fig. 9). These measures avoided emergency gas-plant shutdowns resulting from failure of the bottom rows of tubes, although corrosion still occurred because water was passing through the bundle.

7. Boiler Corrosion[14]*

Ques.—What are factors influencing boiler corrosion?

Ans.—The factors influencing boiler corrosion are no different from any other type of metal corrosion. Moisture and oxygen are always present and are the important factors. Temperature exerts an important influence, and for any given corrosion reaction involving the same relative quantities of combining or reacting elements, the rate of corrosion is increased with an increase in temperature. Likewise, increasing or decreasing the amount of oxygen present increases or decreases the rate of corrosion.

The principal causes of boiler corrosion, agreed upon by most authorities are dissolved gases, corrosive salts, acidity, and electrolytic action.

Ques.—What are the principal dissolved gases?

Ans.—The principal dissolved gases are carbon dioxide and oxygen. The dissolved gases enter with the feed water and are liberated in the boiler. Carbon dioxide enters as a dissolved gas and as a carbonate radical which breaks up into the carbonate salt with the liberation of CO_2 on the application of heat.

Ques.—What are common corrosive salts found in water?

Ans.—These are calcium chloride, calcium nitrate, magnesium chloride, magnesium nitrate, magnesium sulfate, sodium chloride, iron sulfate, and aluminum sulfate. Under boiler heat and chemical influence, these salts decompose giving free acids which attack the metal and initiate corrosion.

Free acids may also be present in feed water. Waters from areas where vegetable decomposition has taken place, or waters from peaty soils are frequently acidic.

Ques.—How is galvanic corrosion caused?

Ans.—Electrolytic or galvanic action corrosion is caused by stray currents. A difference in potential between different parts of the boiler, sets up small electric currents. This causes the liberation of hydrogen and oxygen which in turn causes corrosion. An increase in temperature increases galvanic action.

Ques.—What measures may be adopted to eliminate or minimize boiler corrosion?

Ans.—Oxygen corrosion can be effectively stopped if the oxygen is entirely eliminated. For the proper elimination of dissolved oxygen from the feed water, either an open heater or deaerating heater should be used.

Carbon dioxide corrosion can be prevented by preventing the CO_2 from getting into the boiler, which can be done by external treatment with lime or caustic soda to break up the bicarbonates and later heating to above 212° F. The most common method of checking the possibility of corrosion is by pH measurement.

Acid effects in the boiler can be completely neutralized by maintaining an alkaline condition of the boiler water. Ordinarily an alkalinity sufficiently high to prevent scale will also inhibit corrosion if the corrosion is caused by acids or by salts giving acid reactions.

To avoid boiler corrosion by chlorides, nitrates or sulfates the A.S.M.E. recommends that the concentrations of free sodium hydroxide and sodium carbonate within all steaming boilers be kept in excess of 15 g.p.g. in terms of sodium carbonate.

Inhibitors may retard or even prevent corrosion. The principal inhibitors used are sodium hexametaphosphate and sodium silicate. These are substances which are held as exceedingly thin film on the metal surfaces and interface with the attraction of the metal for the dissolved oxygen.

To overcome galvanic action corrosion, zinc plates can be suspended below the water level in the boiler and a good contact made between the zinc plate and the boiler drum. The plates will be consumed by the oxygen and must be replaced as required to maintain the desired protection.

8. Pipe-Line Corrosion[14]*

Ques.—What are three general methods used to control corrosion in pipe lines?

Ans.—For lines carrying petroleum products: (1) Dehydration of the gasoline may be used, (2) inhibitors may be injected into the stream, and (3) corrosion may be allowed to proceed, but corrosion products are removed by scrapers.

Ques.—Would dehydration be a satisfactory method?

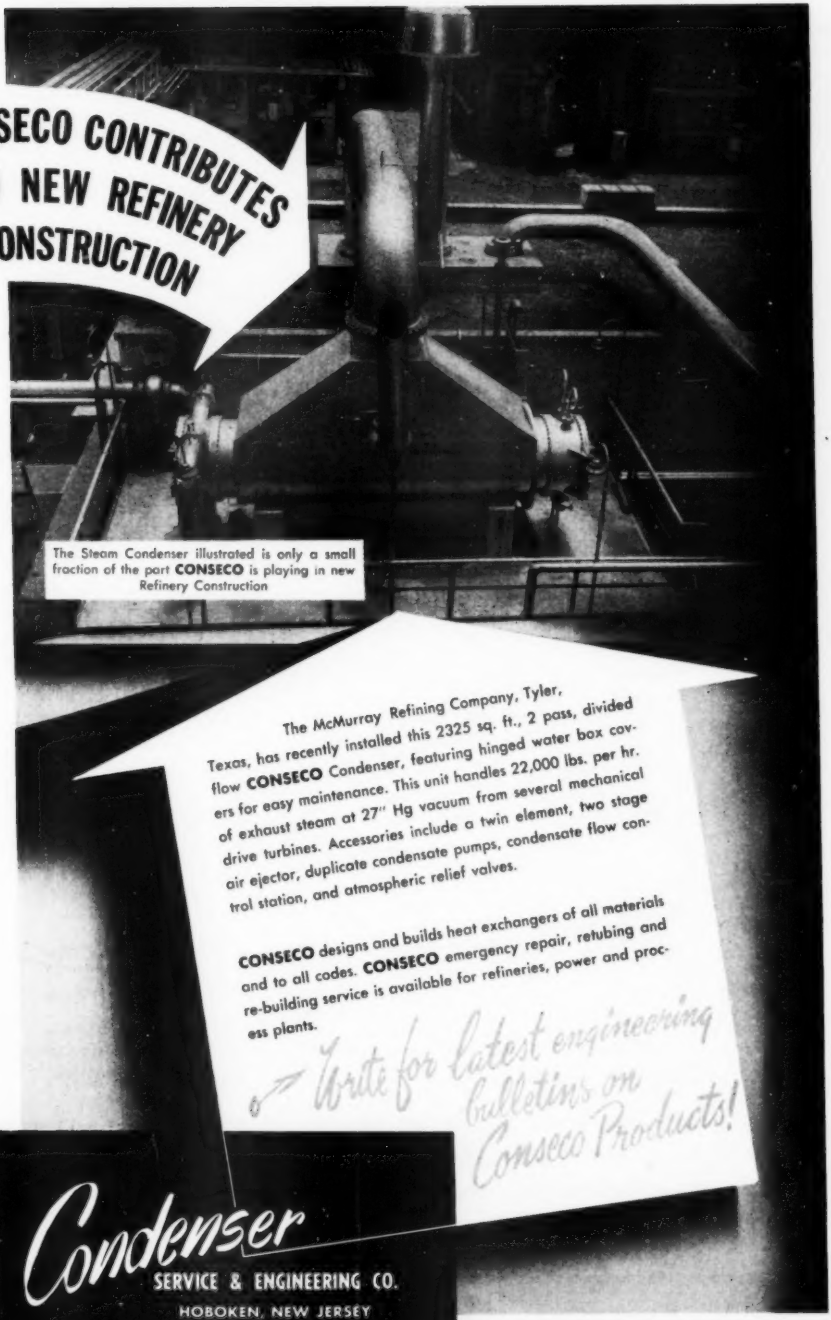
Ans.—For operation in connection with refinery facilities, where steam is available for reactivation of the dehydrating agent, a gasoline dehydration system could be set up at reasonable cost for satisfactory operation.

Ques.—How about the use of inhibitors?

Ans.—This is a widely used method at present. Some of the inhibitors which have given satisfactory results are: sodium nitrite, sodium dichromate and mercaptobenzothiazole. Possible effect of such inhibitors on products which have undergone refinery treating should be checked.

*Original material from The Texas Co specially prepared for this report.

CONSECO CONTRIBUTES TO NEW REFINERY CONSTRUCTION



The Steam Condenser illustrated is only a small fraction of the part **CONSECO** is playing in new Refinery Construction

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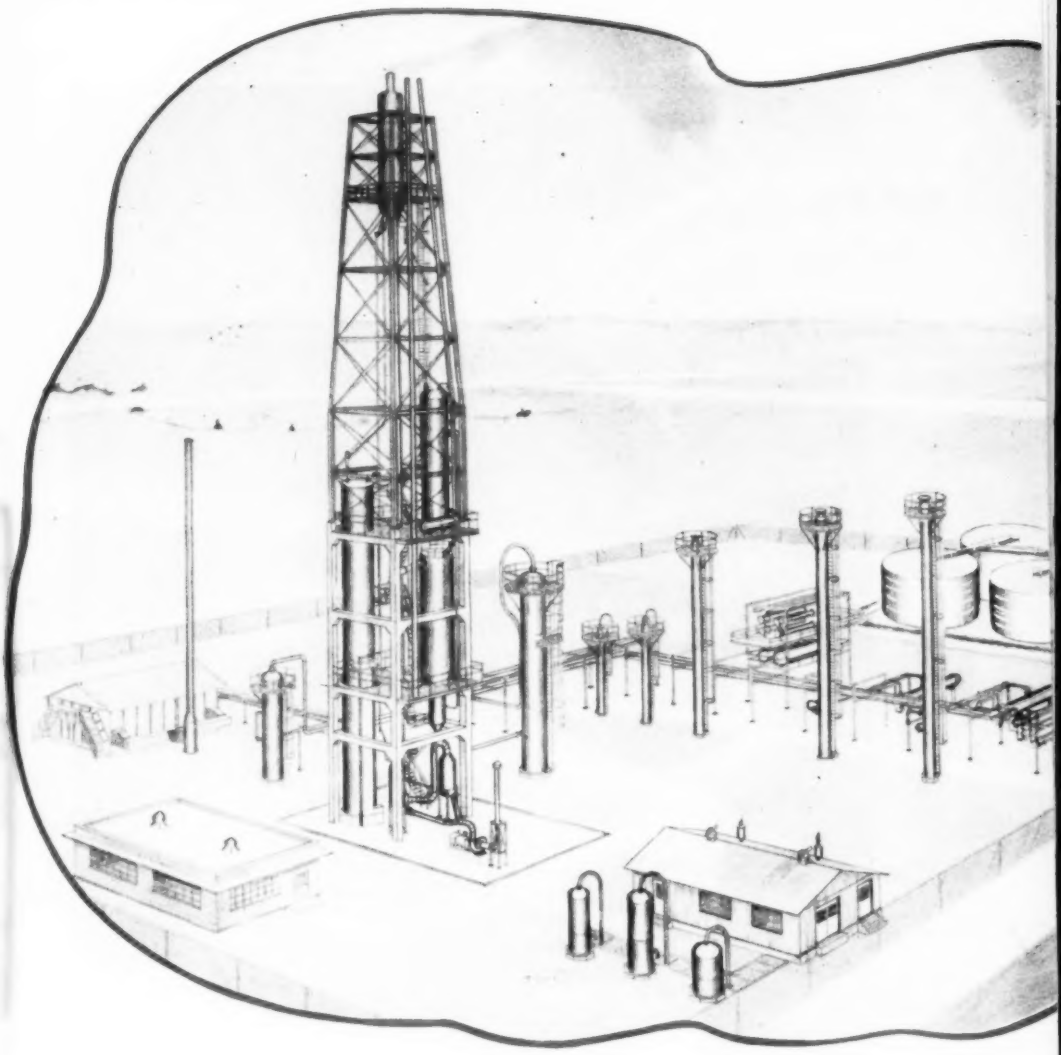

CONSTRUCTION costs are greatly reduced because this design permits shop fabrication of all vessels.

The capacity of this Socony Air-Lift Catalytic Cracking Unit ranges from 1,500 barrels per day of fresh gas oil feed at 90% conversion to 3,000 barrels per day of fresh gas oil feed at 50% conversion.

Koch also designs and builds the following: Complete Refineries — Chemical Plants — All Types of Fractionators — Atmospheric and Vacuum Crude Distillation — Thermal Cracking and Reforming — Fluid Catalytic Cracking — Catalytic Reforming — Alkylation — Perco Desulfurization — Close-out Naptha Fractionation — Propane Deasphalting — Lubricating Oil Plants — Gas Compressor Stations — Natural Gasoline Plants — Evaluation of Refinery Installations and Operations.

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THIS one million dollar plant, complete with Socony Air-Lift Catalytic Cracking Unit, feed preparation, gas recovery and stabilization, will produce finished high octane catalytic gasoline and burner oils.

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Koch is now constructing this Socony Air-Lift Catalytic Cracking Unit for M. F. A. Oil Company, Memphis, Tennessee. In cooperation with Socony-Vacuum, we will be glad to submit information on octanes, yields and economics for your conditions. *Write us today, no obligation.*

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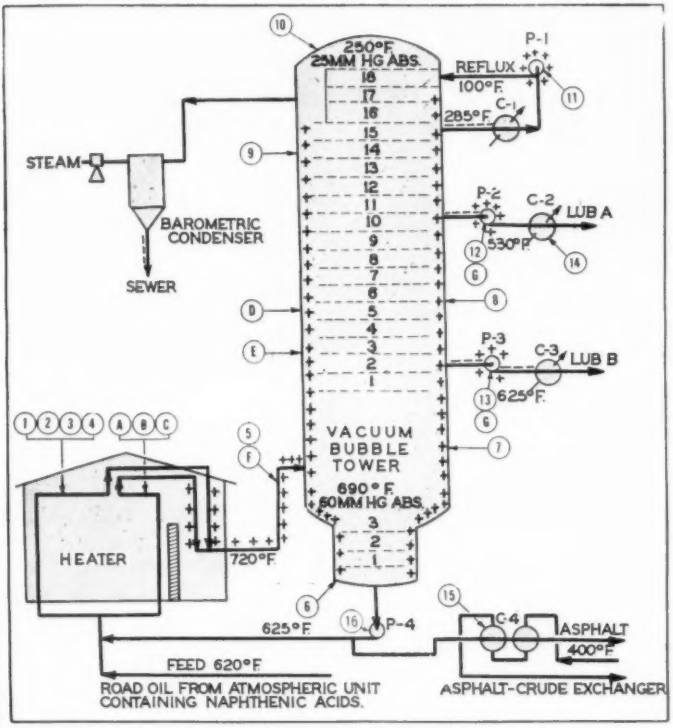

Fig. 10—Corrosion record form.

Corrosion Testing

Ques.—What information is required by the corrosion engineer in order to take effective corrosion-protection measures?

Ans.[5]—The first and most important information is a condensed record of past corrosion experience in all the refining units. Authentic data are required on actual life of equipment, accurate metal-loss measurements, or corrosion rates. Where different types of stocks are processed in the units, separate records should be kept for each kind of stock.

Ques.—What kind of record form might be useful for corrosion data?

Ans.[5]—One type of condensed record form is shown in Fig. 10 and consists of a flow diagram of the unit, showing stock processed, operating conditions along with notes on life of parts or corrosion rates, and where corrosion-resistant alloys were installed. Colors can be used to advantage for outlining portions of equipment where special alloys have been installed, or where corrosion is fairly rapid and additional protection may be needed in the future. All of the reliable corrosion data pertaining to the unit should be on the record. The actual record from which Fig. 10 was copied contained data on over 100 parts of the equipment.

Ques.—How may adequate corrosion data be obtained?

Ans.[5]—Thickness and diameter measurements of equipment parts is the usual means of determining corrosion rates in units. It is also advisable to use "corrosion reference points" consisting of a noncorroding alloy installed in vessels and large lines as permanent surfaces from which to measure the metal loss by corrosion with the aid of a depth micrometer.

Ques.—Why should corrosion-resistant alloys be exposed in the unit at the start of the operation?

Ans.[5]—Some of the materials used in the initial construction may prove inadequate and if processing is at a rate which is considerably higher than the design rate, the increased velocity may lead to severe corrosion. A more corrosive stock may be used or operating conditions may be changed.

Ques.—What alloy materials are usually exposed in oil-refining units?

Ans.[5]—Carbon steel, cast iron, Ni-resist, 5 per cent chrome-moly steel, type 304 steel, type 316 steel, monel, 70-30 copper-nickel, admiralty metal are some of the materials that may be exposed.

Ques.—How can proper construction materials be selected and corrosion allowances be set up for new processes?

Ans.[5]—The best method is to conduct extensive corrosion tests in pilot plants. Such tests are expensive but the selection of materials by this means will nearly always result in practically trouble-free operation of the full-scale plant.

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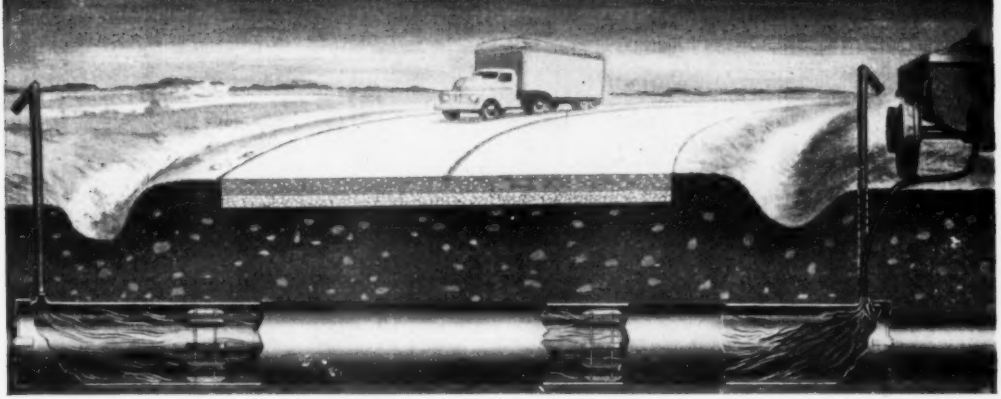

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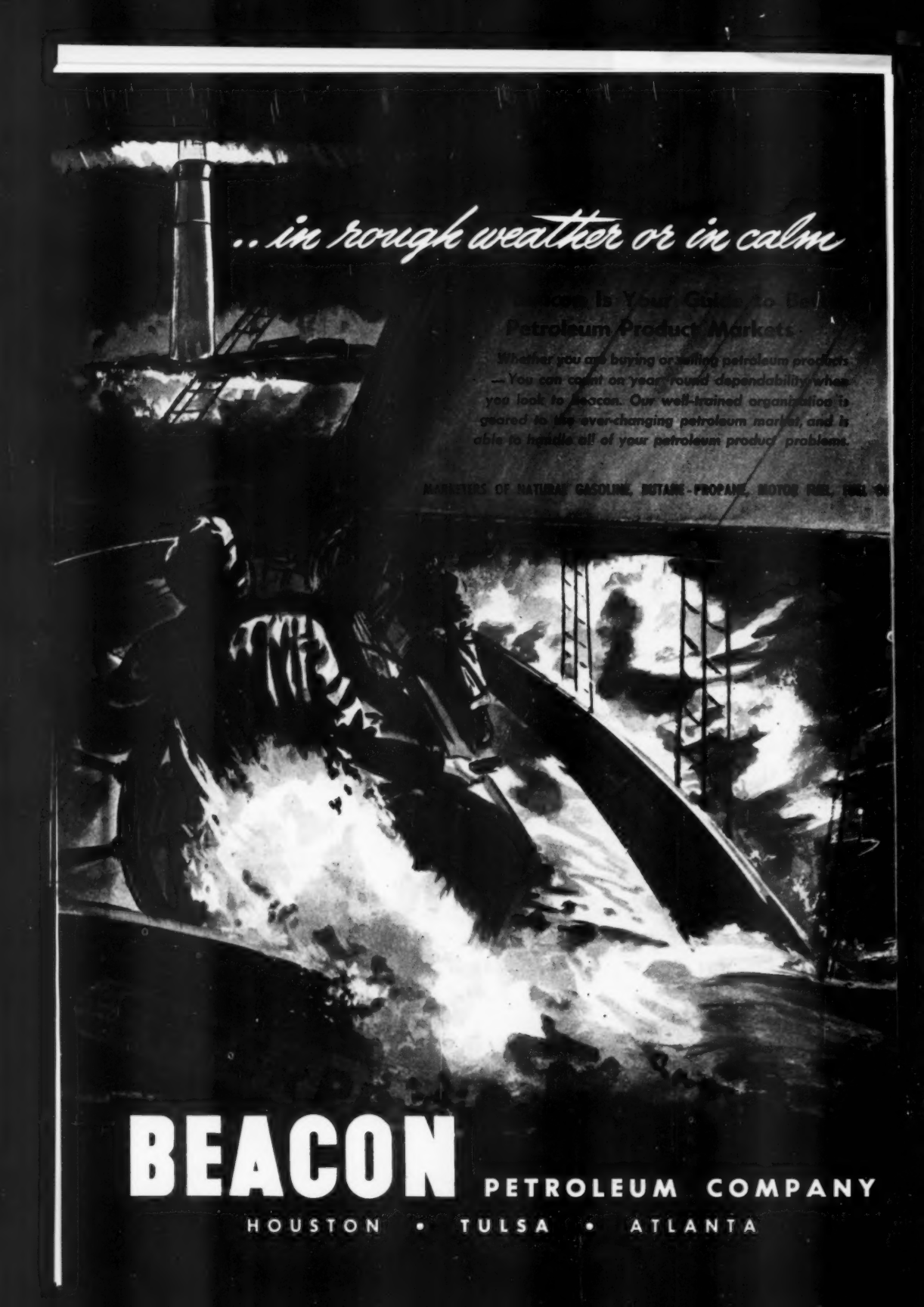
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Engineering Inspection for Corrosion Control

by F. A. Upson*

Economical, safe operation assured by Indiana Standard's inspection group

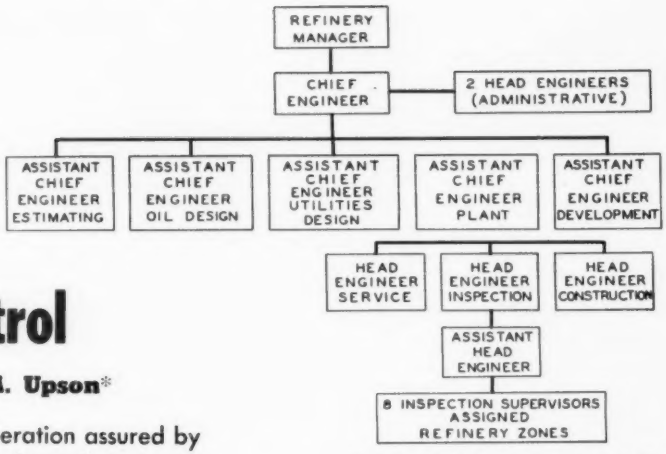


Fig. 1—Administrative chart of the engineering department at the Whiting refinery shows organization of inspection group.

ENGINEERING inspection has become an important factor in controlling corrosion at the Whiting refinery of Standard Oil Co. (Ind.). Management's provision for a well-organized inspection department, adequately staffed by professional engineers, is credited with a program which maintains a constant and accurate check on equipment service. An orderly system of records in turn provides valuable information for the prevention of accidents, development of corrective measures, and design of future operating units.

Organization of Inspection Group

The inspection group at Whiting is an integral part of the refinery's engineering department. Fig. 1 outlines the administration of engineering functions at the 208,000-bbl. per day refinery, and shows inspection as one of the three subdivisions under the supervision of the assistant chief engineer for plant engineering.

A head inspection engineer and one assistant coordinate the work of eight inspection supervisors, each of whom is responsible for a sector of the plant. The remaining 60 members of the group excepting those with administrative duties, are assigned to the supervisors as required. This system permits concentrating the large number of technical inspectors needed for shutdowns of various units through the refinery. It further provides a sufficient technical staff to follow through with the transcribing of records and preparation of reports.

The duties of the engineering inspection group are divided into three general categories: (1) new construction, (2) equipment manufacture, and (3) maintenance. The problem of combating corrosion enters into the group's duties in inspecting new construction and shop fabrication. But it is the maintenance inspection of installed equipment that pertains most directly to the control of corrosion.

Maintenance Inspection

Most maintenance inspection takes place during the coordinated periods of unit shutdown, in accordance with previously prepared work lists. Such inspections have three immediate objectives. They detect quantitatively,

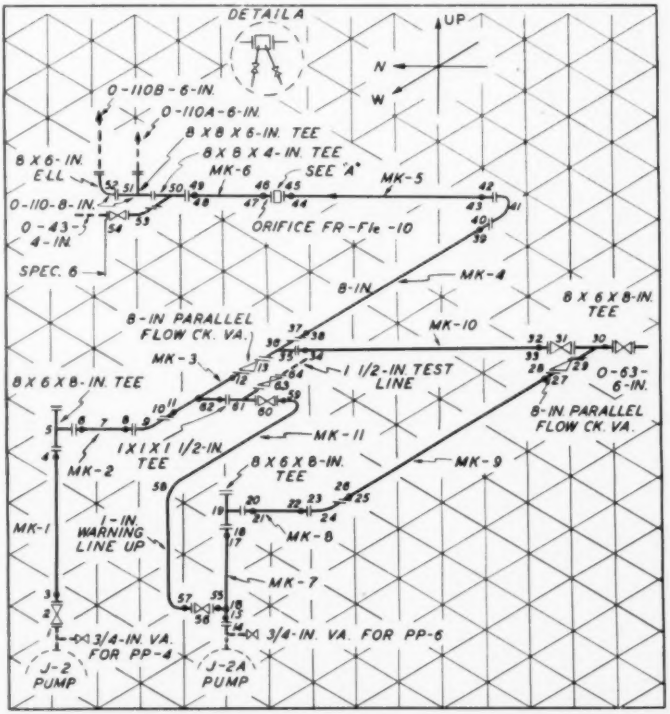


Fig. 2—This piping sketch is typical of hundreds of sketches which aid inspectors in examinations of refinery equipment.

*Head inspection engineer, Whiting refinery, Standard Oil Co. (Ind.)

evidences of deterioration due not only to corrosion but also to erosion, cracking, spalling, sagging, and settlement. They form the basis for recommendations of suitable methods of repair or replacement such that continued safe operation may be assured. They further establish that the repair or replacement is satisfactorily completed.

In making these important inspections, and in recording, plotting, and interpreting them, much reliance is placed on the individual judgment of carefully trained personnel. The employment of professional engineers is favored for inspection work.

Almost all new engineers employed at the refinery are first assigned to the inspection departments, where they are teamed with more experienced men for personal on-the-job training. This policy of individual instruction and observation offers three principal advantages. It offers the new engineer not only a first-hand contact with the complexities of modern refining techniques, but also a measure of practical field experience, both of which are necessary adjuncts to his basic engineering schooling. Further, it offers him a free opportunity to demonstrate initiative, aptitude, and ability to learn and provides ready recognition for such characteristics through direct observation by competent supervising engineers.

With a few years' experience in inspection, new engineers may then be assigned to design, development, or other engineering work in the refinery. They take with them a practical familiarity with refining equipment and a fundamental knowledge of refining techniques.

The engineering inspector must examine, measure, and test from time to time, almost every type of processing equipment to be found in a refinery, in addition to the auxiliary facilities. These include: foundations, furnaces, stacks, exchangers, condenser boxes, pressure vessels, tanks, structural steel work, stanchions, piping (including valves and fittings), buildings, pumps, compressors, turbines, elevators, separator boxes, insulation, mechanical handling equipment, boilers, etc. In many cases these inspections are on a regular schedule. The extent and frequency of such inspections depend, in any particular instance, on the class of equipment involved, the conditions under which it operates, its probable physical condition as indicated by previous inspec-

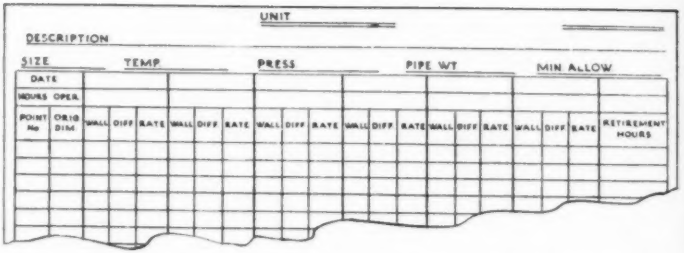


Fig. 3—This "point sheet" is used to record inspection data and to compute corrosion rates and expected equipment life.

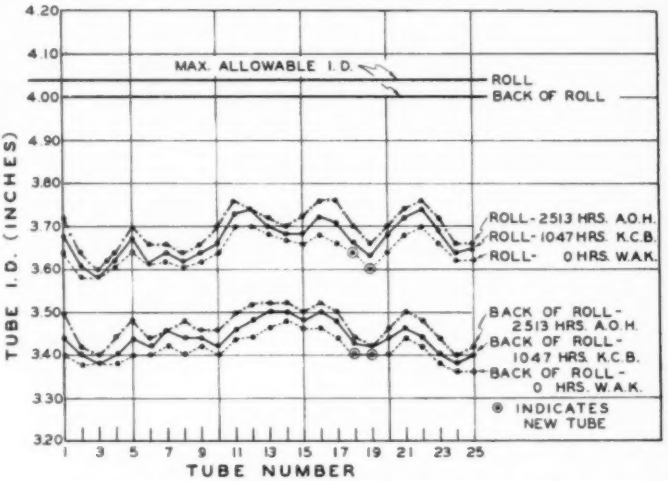

MAX. ALLOWABLE I.D.
ROLL
BACK OF ROLL
ROLL - 2513 HRS. A.O.H.
ROLL - 1047 HRS. K.C.B.
ROLL - 0 HRS. W.A.K.
BACK OF ROLL - 2513 HRS. A.O.H.
BACK OF ROLL - 1047 HRS. K.C.B.
BACK OF ROLL - 0 HRS. W.A.K.
⊛ INDICATES NEW TUBE
TUBE I.D. (INCHES)
TUBE NUMBER

Fig. 4—Inspection data on furnaces are plotted to determine tube service under corrosive conditions.

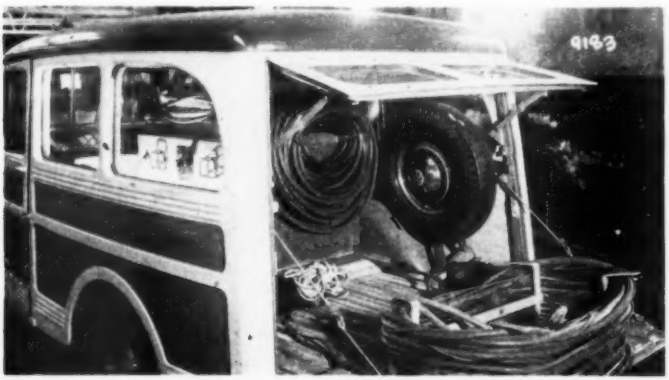


Fig. 5—Magnaflux machine is mounted in Jeep station wagon to permit easy mobility. Three such units are in use at Whiting.

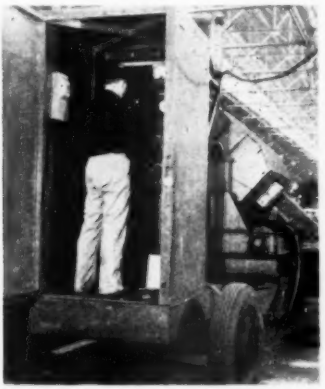
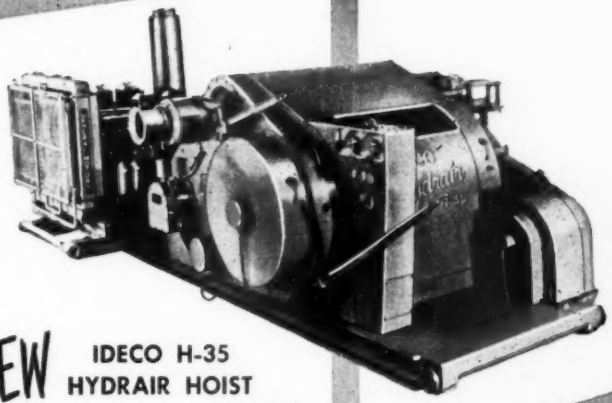


Fig. 6—Semiportable X-ray unit used for routine inspection.



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The H-35 is available as a single-engine or two-engine rig; either skid mounted or as a trailer mounted Rambler Rig.

IDECO's new rig is equipped with SKF Spherical Roller Bearings on the input shaft, main drum shaft, cathead shaft, hydromatic brake shaft and countershaft. The sprocket hubs are equipped with SKF Deep Groove Ball Bearings.

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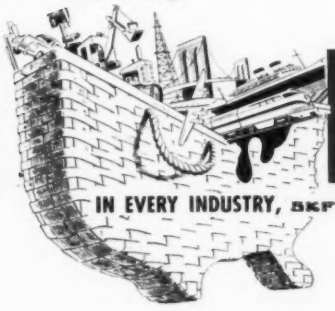

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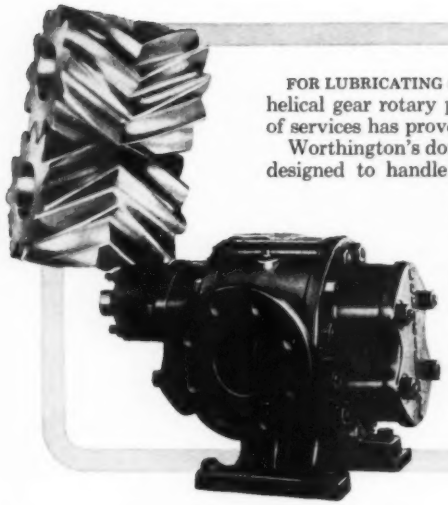

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Worthington's double-helical or "herringbone" gear rotaries are specially designed to handle extremely viscous or lubricating liquids. Each unit operates smoothly and quietly whether its capacity is 1 or 5,000 gpm. All sizes have a maximum pressure rating of 500 psi.

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P.2.1

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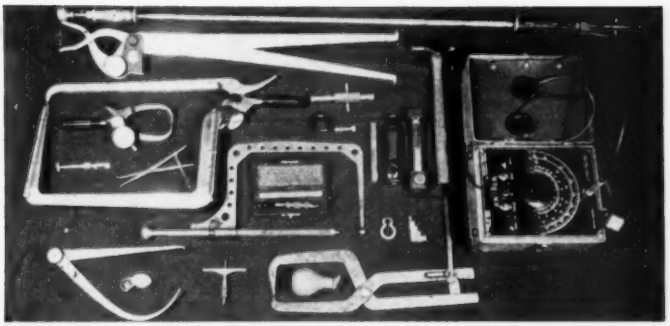

Fig. 7—Small tools used in inspection include Audigage, numerous calipers, and ball peen hammer. Twenty-foot extension calipers are in use.

tions or preliminary examination, its age, the stock processed, and in some cases, certain legal requirements.

After the inspection and reconditioning of a large processing unit has been completed, a full report must be issued by the inspection department covering inspection findings, repairs made, and recommendations for the future. These reports are supplemented with photographs, diagrams, and statements of specific conditions found. They go further than mere reports of observed conditions. The record of repairs made generally include not only a listing of such repairs and how they were made, but goes further in discussing reasons for selecting repair methods, explanations of difficulties encountered and why they were encountered, and suggestions for minimizing such difficulties next time. Recommendations for the future are made on anticipated replacement requirements, listings of items requiring particular additional inspection or repair at subsequent shutdowns, suggestions for modifying design or specification in future units, recommendations for changes in materials, and sometimes recommended length of run based on equipment conditions.

Inspecting Methods

Of all the various types of inspection equipment and techniques available, the process of visual examination is considered the most important. This again reflects a policy which favors employment of professional engineers to do the actual inspecting of equipment. It is mainly through visual examination that proper locations and methods for determining quantitative data can be established. Furthermore, the evaluation of quantitative measurements depends often on the results of visual inspection.

Among the various types of instruments, equipment, and techniques that are employed in inspecting are: tension and compression testing machines, hardness testers, photomicroscopes, Magnaflux, Zyglo, supersonic thickness indicators, radium capsules, X-ray, numerous calipers and depth gages, mirrors, magnets, and the common ball-peen hammer. All of the foregoing, however, are considered adjuncts to the basic function of visual inspection. It is the firm belief at Whiting that rational and intelligent inspection of this sort, conducted by alert men, determines basically where and how to supplement the inspection and in some cases whether to inspect further at all.

Since inspections are made personally by technical men, the group is delegated responsibilities beyond the routine reporting of equipment condition. Decisions or at least recommendations regarding retirement, replacement, repair, or modification of equipment are made by personnel who know what they are talking about through first-hand inspection. Considerable latitude along the lines of interpretation is given inspectors, guided and advised by experienced supervisors.

Records and Their Uses

The maintenance of a complete and accurate record system is of basic importance to the engineering inspection function. In order for inspection records to be adequate for these purposes, it is necessary that considerable time be spent on them to assure their accuracy and completeness.

But even the finest record system is comparatively useless unless it is given sufficient study and interpretation to make it reveal what it has to tell. Careful study of inspection records reveals, as nothing else can, the need for additional inspection which might prevent a costly unanticipated shutdown or even a disastrous accident. It is through perusal of inspection records that changes in corrosion rates may first be detected.

Whenever it is necessary to choose between doing record work and field work, the latter must usually take precedence. However, as experienced inspectors well know, this is in no sense an implication that careful, painstaking study of records is unimportant.

The basic inspection records are the

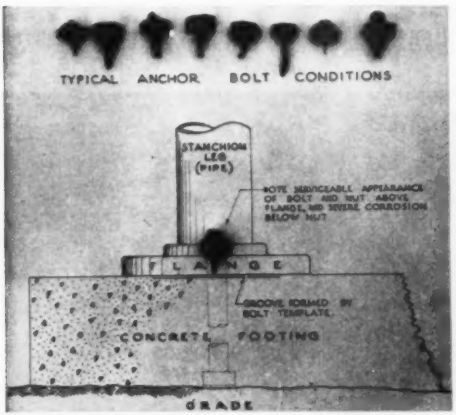
TYPICAL ANCHOR BOLT CONDITIONS
STANCHION LEG (PIPE)
NOTE SERVICEABLE APPEARANCE OF BOLT AND NUT ABOVE FLANGE, AND SEVERE CORROSION BELOW NUT
FLANGE
GROOVE FORMED BY BOLT TEMPLATE
CONCRETE FOOTING
GRADE

Fig. 8—Severe corrosion of apparently sound anchor bolts was found during routine inspection.

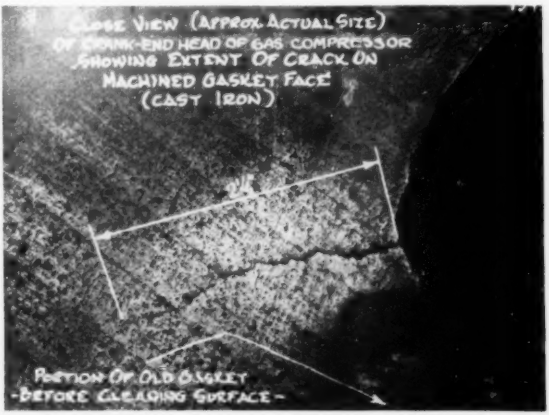
CLOSE VIEW (APPROX ACTUAL SIZE)
OF CRANK-END HEAD OF GAS COMPRESSOR
SHOWING EXTENT OF CRACK ON
MACHINED GASKET FACE
(CAST IRON)
PORTION OF OLD GASKET
-BEFORE CLEANING SURFACE-

Fig. 9—Routine inspection of gas compressor cylinder, in use 9 years, showed two bad cracks, one of which is shown above.

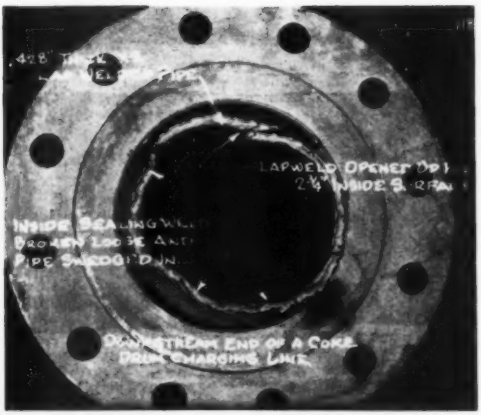

Fig. 10—Near rupture in coke drum charge line revealed by inspection.

field sheets, filled out by inspectors on the units. To aid them in this work, the department maintains a complete file of plant sketches. These basic sketches depict all types of equipment, such as vessels, valves, fittings, compressors, pumps, furnaces, exchangers, condensers, etc. Each drawing provides for numbering of points according to a standard orientation.

Specific lines and over-all units in the refinery are sketched in oblique projections which are oriented to the four compass points. Fig. 2 is an example of a pipe drawing, showing numbered valves, orifices, flanges, welds, elbows, and other fittings. In addition, these sketches, drawn roughly to scale, include such data as line sizes, specifications, operating conditions, original and rejection thicknesses and a general description of the subject.

Field sheets, made out on the inspection job, include caliperings and other measurements plus notes and remarks on all observations. All these data are keyed by number to the proper points shown on the field sketches. Each field sheet contains the date and the inspector's name.

Following an inspection, these data are transferred in pencil to what are called point sheets. Field sheets together with their supporting notes are then microfilmed and filed for possible future reference.

Point sheets show side-by-side records of consecutive inspections of an item of equipment. Fig. 3 illustrates a typical point-sheet form. In addition to the general information on the subject item and the measured wall thicknesses for each inspection, the sheet shows differences and computed corrosion rates determined after each calipering. All equipment replacements are so noted, as well as changes in specifications. Dates of inspection and transcription are listed, together with the names of inspector, transcriber, and computer.

Thus, the point sheets show complete histories of all units, lines, etc, in the refinery. Computed corrosion rates permit extrapolation to determine future dates for inspection and replacement. Comparison of successive rates sometimes reveals rate changes due to altered processing conditions or otherwise.

Further records in graphical form are kept on certain classes of equipment. An example is the tube chart kept on all furnaces showing high corrosion rates. A sample chart of this type is shown in Fig. 4. Tube numbers are keyed to furnace-elevation sketches. Charting tube caliperings both in the roll and back of the roll permits easier visual interpretation of corrosion rates. By comparison with plots of maximum allowable inside diameter, replacement of individual tubes or banks can readily be anticipated for future shutdowns.

Such records require many man-hours in their preparation, maintenance, and study. Their importance justifies employment of enough engineers to handle both field inspection work and record keeping.

Inspection Results

Inspection costs are sometimes regarded as "expenses." Actually, inspection is seen to be one of the most economical forms of insurance when consideration is given to the cost of doing without enough of it. The need for inspection becomes ever more impelling as operating conditions increase in severity, as the processing of sour stocks becomes more prevalent, as replacement costs and length of construction periods increase and as refining equipment becomes more complex and difficult to obtain.

Figs. 8-12 illustrate a few typical cases where routine maintenance inspection has paid off at Whiting. It should be noted that each of the conditions shown very probably would have caused either a serious fire or accident, or an expensive, unanticipated shutdown, or both had it remained undiscovered. Regular, careful, intelligent inspection is virtually the only way conditions such as these can be detected. Without counting possible personal injuries, loss of life, or loss of operating revenue, the direct cost of just one such mishap could easily exceed the entire cost of running inspection department for a period of several years.

Engineering inspection is a progressive and highly specialized professional field based on engineering fundamentals. It requires the mastery of many special techniques and the cultivation of many special skills. Consequently, engineering inspection work cannot be handled either efficiently or economically by personnel who engage in it on a part-time basis, or who are not of professional caliber.

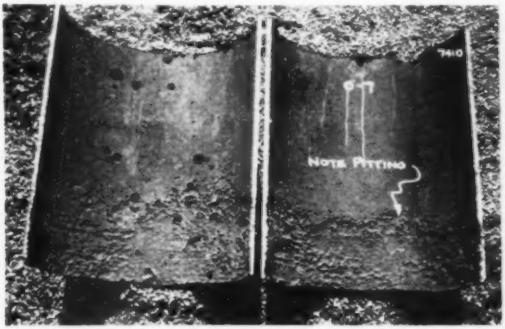

Fig. 11—Pitting reduced wall thickness to half of normal rejection thickness before discovery during inspection.

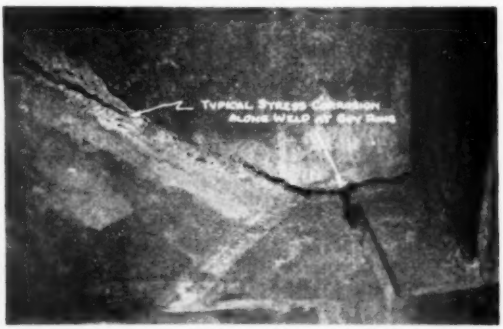

Fig. 12—Stress corrosion at attachment welds of pipe still stack and guy ring discovered by routine inspection.

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HERE'S WHY:

. . . because NATIONAL AIROIL "Airocool" Tandem Units are *more* than just combustion equipment. They are an *exclusive* Combustion System which has *proved* many more hours "on stream" without shutdown.

"Airocool" Tandem Combustion Units (firing dirty refinery gas; uncut asphalt; refinery fuel oils) hold hot air in the combustion zone until fuel and hot air are mixed thoroughly. This means that combustion takes place in a hot zone; the result . . . increased combustion efficiency with a minimum of excess air.

NATIONAL AIROIL Tandem Units add up to 16% further flame travel *without extending the furnace front* . . . eliminating flame impingement on bridge wall and tubes, allowing longer life for those elements . . . and because of this added flame length secondary air is controlled easily and accurately.

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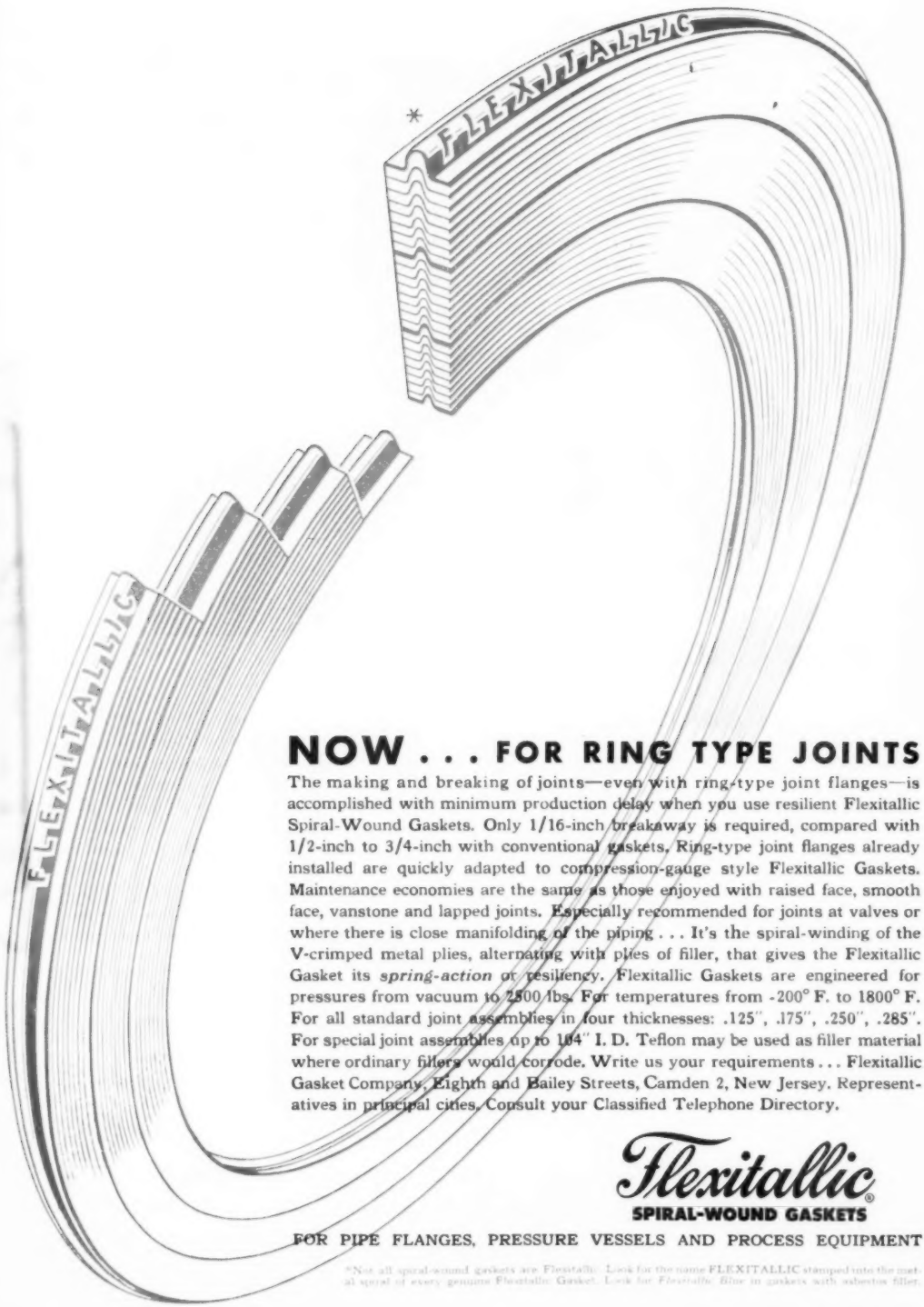

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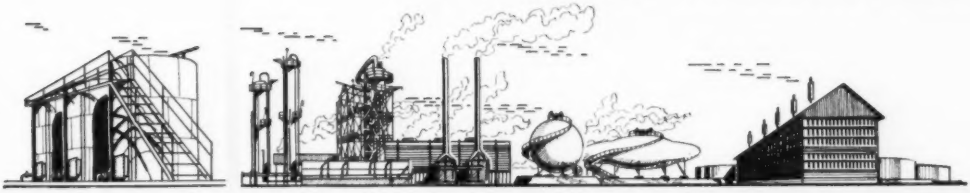
How to Combat *Corrosion*

IN PROCESSING OIL AND GAS



Corrosion . . .

Is Nature's answer to man's meddling. Only the works of man are subject to corrosion—the process by which Nature seeks to restore all substances to a condition of complete and uniform equilibrium.

Is the destruction or damaging of a metallic structure by chemical or electrochemical reaction with its environment.

Is rarely simple; reactions may be profoundly influenced by minor constituents in the metal or by mechanical, chemical, electrical or biological factors in the environment.

Costs American industry five billion dollars a year; at least one hundred million of this is in petroleum refineries.

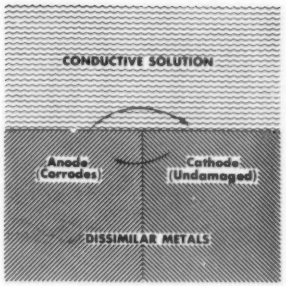
Special illustrated report prepared by Marshall E. Parker, Houston consultant, and The Oil and Gas Journal.

. . . Can, in most cases, be controlled

BASIC TYPES of Corrosion

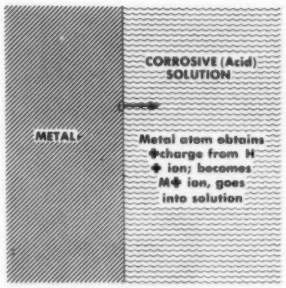
1. Electrochemical . . .

In contact with an electrically conductive liquid—usually water with dissolved substances—two parts of a metallic structure may exchange electric current. The area where the current flow is from the metal to the solution is the **anode**, and is corroded by the process; the area where the flow is from the solution to the metal is the **cathode**, and is usually undamaged. The potential which causes the current to flow is always due to a **difference** of some kind between the anode and cathode; a difference in the two metals, a difference in the concentration of the solution at the two areas, a difference in the temperatures, a difference in the amount of oxygen, or some other kind of difference. Rate and distribution of attack may be influenced by conductivity of solution, relative areas of anode and cathode, velocity of flow, formation of nonconducting films, and many other factors.



2. Direct chemical attack . . .

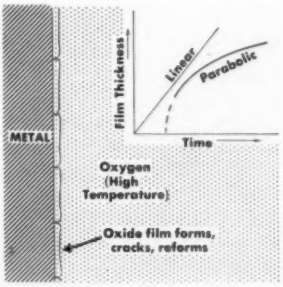
Fundamentally, this is also electrochemical in nature, since electron exchange is involved. No current flow is detectable, however, nor are there definite anodic and cathodic areas. Theoretical rate, as deduced from the relative chemical behavior of the metal and the corrodent, may be profoundly influenced by: formation of a film capable of stifling the reaction; acceleration or inhibition of the reaction by minute traces of foreign substances; secondary reactions involving corrosion products; mechanical removal of protective films, as by erosion, flexure under load, or thermal changes; and by electrochemical activity between the metal and primary or secondary corrosion products.



3. Dry oxidation and tarnish . . .

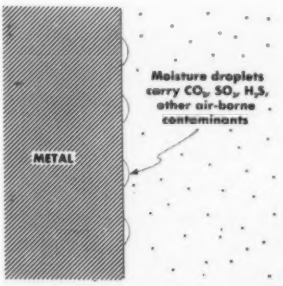
Clean surfaces of many metals, when exposed to air or other gases, form films of oxides and other compounds. At room temperatures, many of these films are invisible, but at more elevated temperatures may reach considerable thickness. Rate of film growth is usually greater at higher temperatures. Rates may be linear, when a porous film is formed (oxide occupying smaller volume than the metal); parabolic, when an impervious film is formed (oxide occupying larger volume than the metal); or logarithmic (mechanism and explanation not well understood). At higher temperatures, and more particularly under temperature changes, film may crack or spall, exposing fresh metal to attack. Bending or stressing of metal can induce or increase spalling.

The presence of sulfur-bearing gases may greatly accelerate oxidation attack. Moisture accelerates attack, and also complicates it by permitting electrolytic activity.

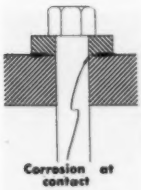


4. Atmospheric corrosion . .

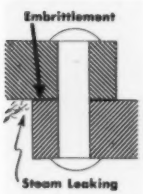
In the final analysis, atmospheric corrosion combines electrochemical attack (bimetallic, crevice, and concentration); direct chemical attack (dissolved acid gases in precipitated and condensed moisture); and oxidation. The large number of structures exposed, and the specialized methods developed to combat it, justify its inclusion as a basic type. Temperature changes, alternate wetting and drying, and the washing action of the elements modify rates of film removal. Rural atmospheres differ from industrial, and industrial atmospheres differ from one another, to such an extent that special tests must often be conducted for the selection of protective coatings and methods.



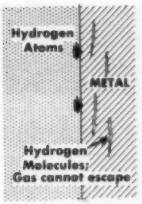
SPECIAL TYPES of Corrosion



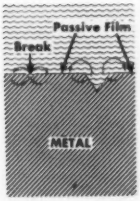
1. CREVICE CORROSION—attack on a surface of a metal partly shielded from contact with the corroding fluid, usually by a nonmetallic material. Typically, this is a concentration cell effect, the shielded area being anodic.



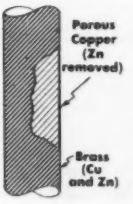
2. CAUSTIC EMBRITTLEMENT — boiler water escaping through and evaporating in a fissure or seam, becomes highly concentrated; the increased alkalinity of the concentrated water causes failure by stress corrosion (see below).



3. HYDROGEN EMBRITTLEMENT and hydrogen attack—hydrogen gas, contained in process fluids or produced electrolytically, penetrates into steel and produces microcracks, blistering, and loss of ductility. Atomic hydrogen (produced electrolytically) combines into molecules and cannot escape.

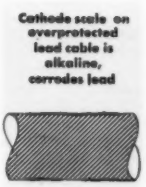


4. PITTING—electrolytic or galvanic attack produces pitting at the anodes. Local failures in the film on stainless steels may be anodic to the remainder of the surface, thus concentrating the attack. Film failure on aluminum acts similarly. Pitting is also characteristic of an inhomogenious environment, such as soil.

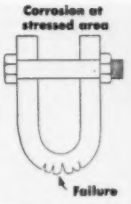


5. DEZINCIFICATION — one constituent of an alloy, such as the zinc in a brass or bronze, may be selectively removed, leaving a porous replica of the original part. Often the whole alloy is initially dissolved, with one element redeposited in spongy form.

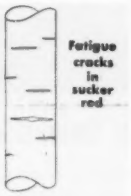
6. GRAPHITIZATION — electrolytic corrosion of cast iron often takes a form very similar to the dezincification of brass described above; iron is removed selectively, and a replica of the part is left which is composed of carbon or graphite.



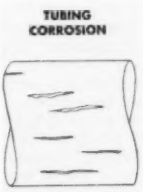
7. CATHODIC CORROSION—although the cathode of an electrolitic cell is not corroded by the electrolytic process, under certain conditions it may be attacked by reaction products formed by the process. A typical example is the corrosion of lead in the highly alkaline environment produced at the cathode.



8. STRESS - CORROSION CRACKING—when even a tiny pit forms in a stressed member, the concentrated stress may either deepen and extend the pit, or crack any film which might tend to form. Under continued exposure to corrosive medium and stress, the crack extends by alternate corrosion and stress failure.



9. CORROSION FATIGUE — a member subjected to alternating stress in a corrosive environment may fail much more rapidly than would be expected under either exposure alone. Continuous removal of protective films, and repeated exposures of fresh metal by small stress failures are responsible for this condition.

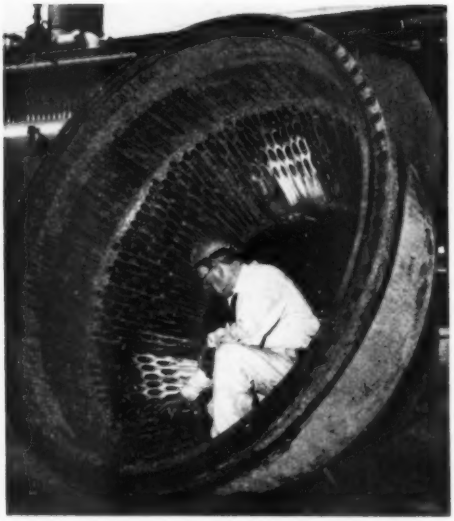


10. EROSION CORROSION — corrosion products which would normally afford a protective film can be scoured off by moving fluids, particularly when abrasive materials are present. This will expose fresh metal, and develop a pattern so obviously a result of erosion that the corrosive factor may be entirely overlooked.

11. CAVITATION or impingement attack—in a process which is very similar to the erosion just described, collapsing gas bubbles in regions of turbulence and local pressure fluctuations may activate serious corrosion. Condenser tubes and pump impellers are subject to this type of attack.

12. FRETTING CORROSION—in a corrosive environment, metal surfaces in contact with one another, and subjected to vibration or other relative motion, can accelerate attack by the continuous mechanical removal of films. Machine parts with small relative motion and high unit loads are subject to fretting corrosion.

LOSSES Caused by Corrosion



Include . . . . 1. Repair Operation

THE lowest measure of the damage done by corrosion is the actual value of the metal removed. It is doubtful if a single case can be cited in which the true loss is only the weight of metal.

A metal part or structure, damaged beyond usefulness, must be either repaired or replaced. The loss is than at least the cost of repair or the total cost of the replaced structure, of which only a very small percentage is actually destroyed by attack.

The replacement or repair of a part involves time and labor; during the time required for the work, production is either suspended or reduced. A small but vital part can thus shut down a large and complex plant, at a cost vastly greater than that of the part or the cost of the repair job.

Minor damage to piping, tank, or vessel can result in the loss of valuable fluids by leakage; further loss of fluids may be involved in making the needed repairs.

Gases or liquids released by leakage may endanger life or property; fires or explosions may result; poisonous vapors may escape; short of disaster, leaking fluids may damage or contaminate goods, equipment, land, or other property.

Internal corrosion of piping, tanks, or vessels, even when negligible insofar as equipment damage is concerned, may introduce undesirable substances into the fluids handled. This is of major importance in the food industries, but is frequently a ruling factor in other chemical processes.

Corrosion products from a reaction in one part of a system may be carried over and act as corrosion accelerators in another.

Corrosion products resulting from a negligibly small attack over a large area, may clog pipes, fittings, or screens.

Instead of removing metal, corrosion may alter the physical properties of a structure in such a way as to cause failure under operating stresses. Graphitization, dezincification, and hydrogen and caustic embrittlement are examples of this, as are stress corrosion cracking and corrosion fatigue.

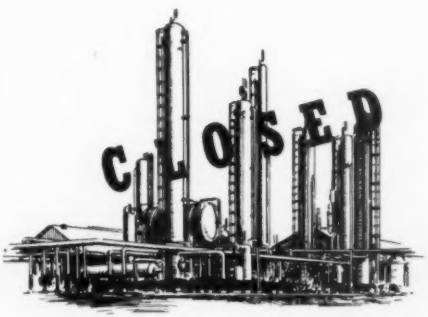
. . 2. Fire or Explosion

Critical dimensions of fitted parts may be altered enough to make performance unsatisfactory, even when the loss of metal is small; fretting corrosion of almost microscopic extent can ruin a precision bearing.

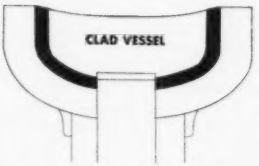
Surface finish may be destroyed by an attack of very small extent; gages, bearings, and instrument components are subject to this type of damage.

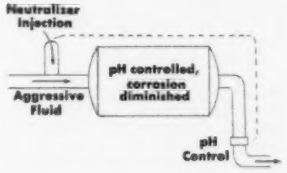
Limited surface attack may lower the value of a product by adversely affecting its appearance; no one will buy oil in a rusty can.

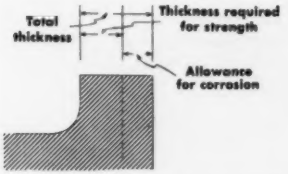
. . 3. Shutdown



WEAPONS Against Corrosion







1. The obvious approach to a corrosion problem is to substitute a metal more resistant to the attack. From the earliest times, metals and alloys have been developed for specific media, and progress is being made continually. When exact data are at hand, recorded and tabulated experience may make possible the selection of an ideal material; when less precise information is available, caution is required, tests must be conducted, and even then changes must often be made.

The substituted material may be used for the entire component; it may be employed as a lining—welded in sheets, a clad metal, as facing metal applied by welding, or as sprayed metal.

2. Nonmetallic barriers can prevent corrosion by preventing contact. Paints and enamels are used in wide variety; builtup coatings are employed; cement and masonry linings serve. Such materials are applied by brushing, spraying, or dipping; some rubbers and rubber-like materials are applied in sheet form.

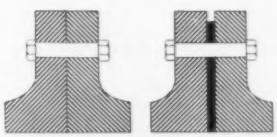
Glass and ceramic coatings for metals are being developed for higher and higher temperatures.

3. The corroding environment itself may be modified in such a way as to decrease its aggressiveness. Acidity and alkalinity have been controlled for many years—before the pH concept was introduced. Automatic control is often effective where the required range is too narrow for manual control.

Inhibitors and passivators operate by modifying the environment in the immediate neighborhood of the metal surface; thus they can be effective in very small quantities. Intermittent treatment is often effective, the film being semipermanent in nature.

Aggressive constituents of the fluid stream, not themselves involved in the process, may be removed by special treatment before entering the equipment subject to damage. Oxygen, carbon dioxide, and hydrogen sulfide are amenable to this treatment.

The temperatures at which reactions take place may sometimes be reduced, with greater savings in corrosion than losses in productivity. Sometimes an increase in temperature is helpful, when it can keep water in the vapor phase.



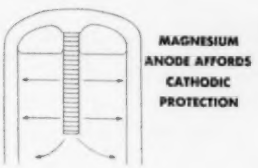
4. The mechanism by which corrosion occurs can often be interfered with in other ways than those mentioned.

Galvanic corrosion will be decreased if the total resistance of the circuit is increased, or if the circuit is broken completely. Galvanic corrosion is decreased by painting the cathode; total attack may be lessened by painting the anode, but this is hazardous, since it may result in concentration of the attack at the few imperfections. Changes in the relative areas of anode and cathode are often effective; a large anode may lose considerable metal without injury.

Diminishing velocities of liquid flow, or smoothing the path at points of turbulence, can do much to eliminate scouring, which often accelerates corrosion.

5. A time-honored method of coping with corrosion is that of simply supplying an excess of metal to be corroded. Seldom is this the best solution, but sometimes it must be used when no other remedy is known. Applied to a small area under heavy attack, it may lengthen the time between replacements enough to represent a very real saving in over-all costs.

One of the systems of cathodic protection may be considered as a device for concentrating all of the corrosion on a set of easily replaceable members.



6. Cathodic protection is a major weapon against corrosion; it is effective against many forms, and is often used against corrosion which is not understood. It is applicable only when the corrosion is taking place at a metal surface in contact with an electrolyte. Its principle is that of overwhelming the corroding potentials by superimposed currents in the electrolyte. The anodes—deliberately sacrificed unless of special materials—must be in the same electrolyte.

The source of power may be direct current from an external supply—generator, rectifier, or other source of d.c. The anodes are variously of platinum, stainless steel, junk steel, aluminum, graphite, and other materials.

The source of energy may be galvanic anodes, of a metal whose natural potential makes it anodic. Zinc and magnesium can be used to protect iron and steel, and steel itself can be thus used to protect copper and copper-bearing alloys.

Corrodents in the Refinery

THE major villains in refinery corrosion are: the chloride ion, the sulfide ion, the hydrogen ion (acidity), the hydroxyl ion (alkalinity), water (the universal catalyst), oxygen, and carbon dioxide.

1. THE CHLORIDE ION is destructive to passivity, and thus may in small concentrations expose a metal surface to the destructive attack of solutions to which it might otherwise be resistant. The attack is likely to be concentrated in a few locations so as to produce pitting in which the damage is disproportionate to the total metal loss.

The high solubility of most metallic chlorides also contributes to the aggressiveness of the chloride ion, since corrosion products are easily removed from the surfaces where they form. This same solubility makes the removal of the offending ion more difficult to effect economically.

2. THE SULFIDE ION appears in petroleum fluids largely as hydrogen sulfide. This acid gas occurs naturally in many crudes, known by this property as sour crudes; it may also be formed by the decomposition of more complex sulfur-containing compounds in distillation and cracking process, and others involving heat and pressure.

It is able to accomplish its greatest damage in the presence of water; very often droplets of water, condensed upon a metal surface, will dissolve hydrogen sulfide from the contacting gases, and, because of its high solubility, build up a concentration all out of proportion to the total concentration in the stream. In this way it is able to do more damage than might be estimated.

The presence of oxygen is necessary for sulfide attack in many cases, and possibly in nearly all.

3. THE HYDROGEN ION is the worst offender in the corrosion of metals at low temperatures—that is, at temperatures low enough to permit the presence of water in the liquid phase. Even chloride and sulfide corrosion is fundamentally hydrogen ion attack — as is all acidic attack. For it is the acquisition of a positive charge from a hydrogen ion which permits an atom of a metal to become an ion, and thus go into solution. What happens next is influenced profoundly by the kind and amount of other ions present, but these secondary steps have no opportunity to occur in the absence of the all important first one.

4. THE HYDROXYL ION, whose presence in a solution in excess as compared to the hydrogen ion is recognized as alkalinity, is responsible for caustic embrittlement and for the destruction of passivity in stainless steels (sharing this responsibility with the chloride ions).

5. WATER.—The presence of hydrogen and of hydroxyl ions naturally implies the presence of water. Water has been described as the "universal catalyst" because of the large number of chemical reactions, not obviously involving water, which take place only in solution. Among these reactions are the majority of those responsible for corrosion. At temperatures below the arbitrary figure of 500 F., under conditions typical of the petroleum refinery, water in the stream is likely to be at least partly in the liquid phase. Under these conditions, soluble substances in the stream are in aqueous solution, and thus are in the ionized or active state. It should not be overlooked that only a small part of the total water content of the stream may be in the liquid phase, and that in this relatively small quantity of liquid, the concentration of dissolved substances may be much greater than the apparent or over-all concentration.

The presence of liquid water also furnishes the electrolyte which is required for the maintenance of galvanic activity. Cells large and small may operate in any part of a complex system—there are always differences of one kind or another to furnish the potential needed to power the cells.

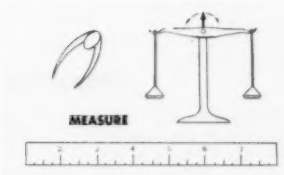
6. OXYGEN is a factor in both low-temperature corrosion, involving electrolytic action, and in direct high-temperature oxidation. In electrolytic action, the principal role of oxygen is that of a depolarizer; by combining continuously with the hydrogen formed at the cathode, it maintains the cathode in an active and conductive state, and thus maintains the rate of attack at the anode. In confined places, even the attack upon steel by as corrosive a medium as sea water may come to a complete halt by oxygen starvation.

Virtually all metals are subject to oxidation at high temperatures. The more resistant metals, such as steel, form oxide films. The thickness and rate of formation of these films depends upon the oxygen availability and upon the temperature. The ability of the film to obstruct further oxidation is dependent upon two characteristics; its porosity and its adhesion. The porosity is determined by the relative volume of the oxide and of the metal from which it is formed; when the oxide is more dense than the metal, the coating is permeable, and oxidation will continue whether the film is adherent or not.

Adhesion of the film depends to a great extent upon the relative expansion of the metal and the oxide, and to the temperature changes to which the surface is subjected.

7. CARBON DIOXIDE does its damage in equipment by dissolving in water to form carbonic acid. Thus it is the hydrogen ion which is the real aggressor, but the ion owes its existence as such to the formation of the acid. Steam and condensate lines are often subject to this attack in a particularly violent form.

DETECTION and DIAGNOSIS of Corrosion



THE effects of corrosion may be detected in three general ways: by the inspection of equipment which has been subjected to corrosion; by the detection of corrosion products as contaminants in the fluid downstream; and by inference, from the observation of phenomena known to be associated with corrosion.

Equipment may be inspected in a wide variety of ways:

1. Visual inspection may disclose pitting, roughening, or thinning of a metal surface; or corrosion deposits may be examined and identified.

2. Direct measurement of weights and thicknesses may be made, in locations where the vessel wall is accessible, or through holes drilled for the purpose and then plugged.

3. X-ray or gamma-ray inspection can give indication of thickness remaining or of some types of internal damage. Back-scattered gamma rays (Penetron) indicate thickness directly.

4. Resonance to high-frequency sound waves (Audigage) measures thickness of metal. Hidden flaws may be detected (Reflectoscope).

5. Magnetic field concentration at invisible cracks can be detected by magnetic powder techniques (Magnaflux).

6. Fluorescent powder can be used to locate invisible cracks in nonmagnetic materials (Zyglo).

7. Magnetic flux variations indicate pits and other discontinuities in nonmagnetic tubes (Probolog).

8. Optical instruments permit the visual inspection of tubing interior surfaces (Tubescope).

9. Interior pitting of tubing can be measured with calipers.

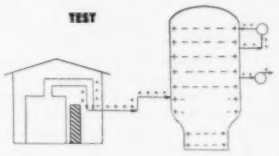
10. Cracks and other internal defects, such as loss of ductility, can often be detected by the hammer test.

11. Pitting on exposed surfaces can be measured with a depth gage.

A corrosion process within a piece of equipment through which a stream of fluid is passing almost always produces reaction products which enter the stream. A process whose products never leave the surface where they are formed is usually a self-limiting process, and hence not often serious. It is frequently possible, without shutdown or inspection, to detect the presence of active corrosion by detecting these products in the stream on the downstream side of the equipment, although the indication will not be very specific as to the seriousness of the action, since it can at best reflect the gross or over-all rate with little indication of the distribution or exact location of the attack.

Iron content of the effluent stream is most commonly used as an indicator of this type. In order to be informative, the analysis must show the total iron content—which will ordinarily appear in several compounds—and data must also be available as to the iron content of the fluid upstream from the equipment in question.

Collateral phenomena by which corrosion may be inferred are: electrical evidence; hydrogen as evidence of diffusion attack; hydrogen in steam as evidence of attack in boilers; oxygen depletion of fluid stream; depletion of other ions; and otherwise inexplicable changes in pH.



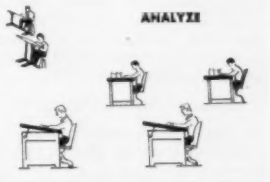
Electrolytic corrosion is always accompanied by the flow of current, although it cannot always be detected. If the anode and cathode are sufficiently separated, and if the metallic path is long enough, there may be a measurable IR drop in the metal. Or, if the electrolyte is accessible, the current flow therein may be detected, or potential measurements may disclose the locations of the anodic and cathodic areas—this is a familiar technique to those concerned with pipe-line corrosion.

High-temperature steam reacts with steel, and one of the products of the reaction is hydrogen.

Hydrogen diffusion through vessel walls may be detected by pressure rise in a steel pad edge-welded to the outside surface.

If the effluent stream contains less oxygen than the influent, then obviously the oxygen is remaining within; perhaps in the form of a scale or a sludge, but very probably as a metallic oxide. The same reasoning may be applied to various other ions.

Changes in pH or in any other measurable characteristic of the fluid, when not explainable by the processes known to be taking place, may be indicative of active corrosion and should be investigated.



Many of the methods just described for the detection of corrosion also serve for its diagnosis. The identification of corrosion products, either as deposits or as carried in the stream, give information as to the aggressive constituents in the fluids.

Pitting, as distinguished from uniform attack, is indicative of galvanic attack or of the breakdown of passivating films; the chloride ion is responsible for this destruction of passivity in many cases. Pitting, as has been mentioned, is more characteristic of acid than of alkaline conditions, since alkalinity tends to destroy the film in its entirety.

Bimetallic corrosion is nearly always obvious to the eye. The anodic metal is attacked in a pattern whose geometrical relationship to the cathode makes the current field of the cell almost visible.

Erosion-corrosion, similarly, is clearly recognized. In the absence of familiarity with this phenomenon it is likely to be mistaken for simple erosion, and such an interpretation can be extremely puzzling when it is obvious that no abrasive material is present.

Microscopic examination of specimens of attacked metal will serve to identify the several types of attack which lead to cracking; physical tests on removed specimens will disclose the loss of ductility typical of corrosion fatigue and embrittlement, either by caustic or hydrogen.

DESIGNING Against Corrosion

Design for Smooth Flow

Steps which may be taken in the design stage to combat the effects of corrosion in the operating stage may be divided into two general classes; first, the incorporation into the process and into the equipment of features which can be expected to minimize the effects of known corrosive conditions; and secondly, the incorporation of features which will make it easier to combat conditions which become known only after operations are under way, or which arise because of changes introduced into the operating conditions.

Minimize Known Corrosion

In the first category must be listed such features as the following:

1. The proper choice of materials of construction, and the correct assembly into the structure. Careful study of available information to determine the most corrosion-resistant material for the given service is most important. If sufficient data are not available, corrosion tests may well be in order.

2. Where dissimilar metals must be used, the correct methods of joining them: they may be insulated from one another, they may be separated in such a way as to minimize damage, or they may be so proportioned as to distribute the attack. Right-angle bends in the piping should be avoided whenever possible.

3. The design of vessels and piping so as to eliminate crevices and pockets in which stagnation may occur or sludge accumulate.

4. Design of piping so as to avoid the turbulence which is likely to cause erosion-corrosion; provision of adequate cross-section to keep velocities low.

5. Design of heat-transfer equipment so as to maintain reasonable uniformity of temperatures; hot spots add little to the total heat transfer, and may accelerate corrosion enormously. The use of concurrent flow in heat exchangers will sometimes enable better control of temperatures, resulting in fewer hot spots and less corrosion.

6. Provision for the injection of inhibitors, neutralizers, and other chemical conditioning substances; automatic control, actuated by pH or other significant factor, is much more effective than manual.

7. Provision for the maintenance and supervision of cathodic protection systems; test leads for checking operation of system without disruption of plant operations.

8. Access to surfaces protected by paints, coatings, and similar materials, for the maintenance and repair of these coatings. Often small breaks will occur in such surfaces, and a little maintenance at the right time will drastically reduce corrosion.

9. Provision of readily replaceable parts which will be subjected to serious corrosion; bypasses and parallel units may make possible maintenance without shutdown.

10. Provision of excess metal at locations where severe attack can be predicted. Equipment sections should be made as small as possible at these points, thus enabling economical replacement as necessary.

. . Parallel Units

Unanticipated Corrosion

Steps which may be taken to facilitate the mitigation of unanticipated corrosion include:

1. Adequate provision for inspection and maintenance of all parts of the equipment. Handholes and other means of access should be provided. Plenty of valves, tees, crosses, and unions should be installed.

. . Inspection

2. Consideration should always be given to the possibility of using two small units in parallel, even where corrosion is not expected; often the additional cost is small, and obviously both inspection and repair are facilitated.

3. Wherever there are conductive fluids, connections may be established for making electrical tests; often insulated lead wires can be brought out without interference with operating conditions. These same connections may be useful for the application of cathodic protection, should it become necessary.

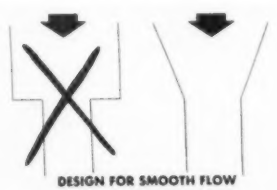
4. In condensers and heat exchangers, additional space in the water boxes may make possible the installation of galvanic anodes if the need arises. Provisions should be made for the easy removal of headers, tube bundles, etc., for inspection and proper maintenance.

5. Fittings should be provided which will make possible the addition of equipment for the injection of inhibitors.

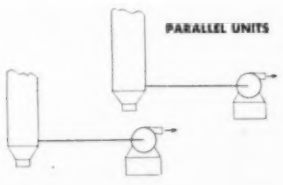
6. Accurate dimensional records will make it possible to detect uniform attack more quickly and more accurately. Special care should be taken with these records in sections where excessive corrosion is anticipated.

7. Means should be provided for the easy taking of samples from the stream in as many places as feasible. Areas in which excessive corrosion is taking place can often be pin pointed by differences in analyses taken at successive points in the system.

8. Mounting brackets and space may be provided for the insertion of test specimens into the stream at various points. In new units, use of test specimens at the start of operations is often recommended as a matter of precaution.

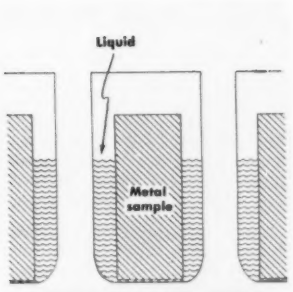


DESIGN FOR SMOOTH FLOW

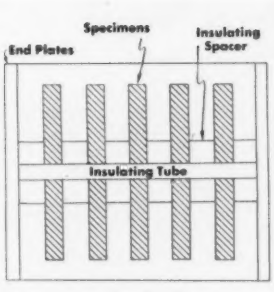


DESIGN FOR INSPECTION

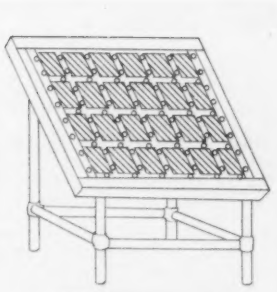
Corrosion TESTING METHODS



COMPARATIVE LABORATORY TESTS



TEST SPOOLS


ATMOSPHERIC TEST RACK

When a new process is to be introduced, or changes made in an existing process; when a new crude is to be handled; when a new unit is to be designed; or when a corrosion problem develops in an operating plant, then some form of testing program must be instituted in order to collect data.

The tests may be conducted in order to evaluate materials of construction, or methods of mitigation, or for the prediction of corrosive effects of a new process.

Testing may be done: in the laboratory, by simulating the actual conditions or by accelerating the attack; in operating equipment, by the insertion of specimens; in pilot plant equipment; or on the full-scale plant.

Laboratory Tests

Laboratory tests are exploratory in nature, and the results can never be applied to full-scale operation with full assurance of their validity. Materials may be proven unsatisfactory, and rejected, on the basis of laboratory tests alone; but materials or methods which are successful in the laboratory can only be given conditional acceptance. Accelerated tests obviously do not duplicate operating conditions, and results cannot be transferred to normal situations; but they are valuable for comparing materials, and are extremely useful for quality control, where the correlation between test and service has been established.

Test specimens exposed to corrosive conditions in operating equipment may take several forms; preliminary tests will usually involve large numbers of relatively small specimens; as the test proceeds and the choice narrows, a larger number of specimens of the materials still under consideration should be exposed to a wider variety of conditions, and for longer periods of time. It is difficult to expose specimens in environments which are entirely typical, and the results of such tests, while more dependable than those in the laboratory, are not completely conclusive.

Atmospheric exposure tests, for paints or for materials to be used without painting, are of considerable value, since the atmospheric conditions at any particular site are likely to be unique. Even when the materials in use are "satisfactory" there is no assurance, without continuing tests, that they are the very best available for the purpose.

Pilot Plants

Pilot plants built for the testing of processes afford an opportunity for the investigation of corrosion conditions, and for the testing of materials and methods with which to combat them. Extrapolation from the pilot plant to the full-scale plant offers no more difficulty in the field of corrosion than in actual operations; the correlation can be generally good, but cannot be depended upon to be perfect. Because of the intermittent operation of pilot equipment, with its attendant variability of conditions, corrosion may be more serious than in equipment in continuous operation. On the other hand, the short runs typical of pilot operations make careful measurements necessary in order to determine rates with sufficient accuracy.

Plant Performance

Every plant in operation is a full-scale corrosion test. The success with which it functions as such depends in large measure upon the care with which inspections and measurements are made, and upon the completeness with which records are kept. Evidence of attack, discovered at the tenth inspection, is far more significant if it is known that there was none visible at the ninth. Photographic inspection, with camera and lighting conditions carefully duplicated, is very useful in determining the progress of a corrosive attack.

Often one or more of a set of identical units may be replaced with one of a material to be tested. Such a test will be valid only if the replaced unit is typical, and if its presence among the others does not introduce a disturbing factor. As an example, a short section of copper tubing installed in a run of steel pipe may be cathodically protected by the steel; the fact that it is not attacked does not prove conclusively that copper is satisfactory for the service.

CONTROLLING UNANTICIPATED *Corrosion*

Apply Linings . .

It is very difficult to give any but general principles for the control or mitigation of corrosion which appears where none had been expected.

The first step is to attempt to discover the mechanism of the corrosion, in order to select an appropriate means of interfering with its operation. Often this cannot be done in the time available, and some temporary expedient must be adopted in order to get the plant back on stream. The subject should then be attacked with vigor so that a solution may be found in time for the next turnaround; as much data as possible should be obtained for study, whether obviously relevant or not.

Substitution of material is a method of last resort, since the equivalent is already in existence. Small components, which have already been rendered useless and must be replaced, can be handled by substitution; the replaced item must then be considered as a test. Larger units, which have been damaged but not destroyed, may be lined by any of the several known methods, if this approach seems appropriate.

The simplest approach in many cases is modification of the corroding agent through some form of treatment; even when the precise nature of the attack is not known, suspicion must be directed toward any characteristic of the fluid which differs from fluids similar in most respects, but not giving trouble, either elsewhere in the system or in other plants.

Reduce Throughput . .

If no other remedy seems worth trying, it is often necessary to reduce the operating temperatures. This will almost invariably entail an undesirable reduction in throughput, but it may be unavoidable, at least as a temporary measure while more effective measures are sought.

Reduction in turnaround interval may also be forced upon the operator, in order to gain access for the needed inspections and repairs, when corrosion is more serious than had been anticipated. Here again the economic loss may have to be borne as a temporary expedient, pending a better solution.

Where the corrosion is taking place at a metal surface in contact with an electrically conductive fluid, cathodic protection is almost certain to be effective if means can be devised for its application. This is true even in many cases where the actual cause of the attack cannot be determined; it may be true in cases where eventually a less expensive measure can be found.

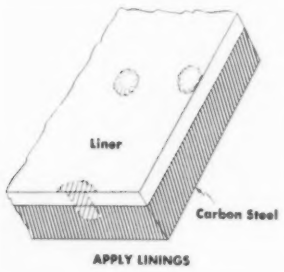
In water, the application of cathodic protection is nearly always feasible, except on the interior surface of narrow tubes. It may be necessary to use an external source of power, but in a great many instances galvanic anodes will be the simplest solution. In selecting a material for such anodes, it is well

Apply Cathodic Protection

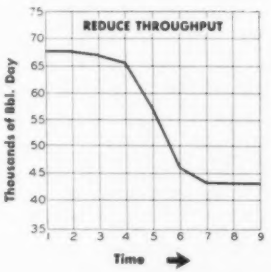
to investigate the possibilities of several metals; magnesium and zinc, standing high in the electromotive series, are most commonly used for the protection of iron and steel; it should not be overlooked, however, that steel itself is anodic to such metals as copper and most high-copper alloys, and can be used for their protection.

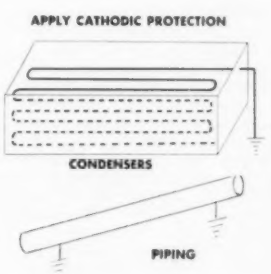
The substitution of stainless steel or copper alloy tubes for steel tubes in heat exchangers often leads to galvanic attack upon the headers and tube-sheets. This vicious circle can be extended further by the substitution of the expensive alloy for these parts. But cathodic protection, not applicable within the tubes themselves, may nevertheless be employed to prevent the attack upon the steel tube sheets which is thus involved. The reason for the difference is in the geometry of the current flow; any attempt to introduce cathodic protection current into a tube merely results in a heavy concentration of current near the end, with almost zero current density at a distance of two or three diameters down the tube.

It is highly probable that cathodic protection can and will be successfully applied to a large number of corrosion problems now being treated with indifferent success by other means; its electrochemical basis makes it directly applicable to the fundamentally electrochemical cause of virtually all corrosion.

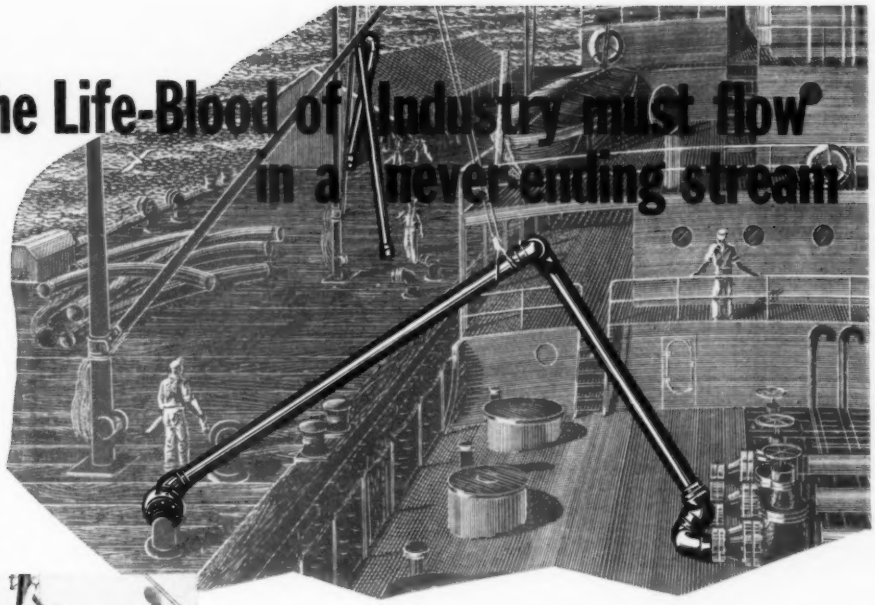


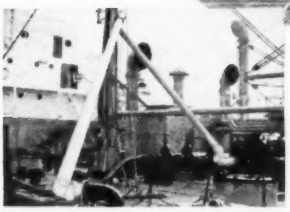
APPLY LININGS





The Life-Blood of Industry must flow in a never-ending stream





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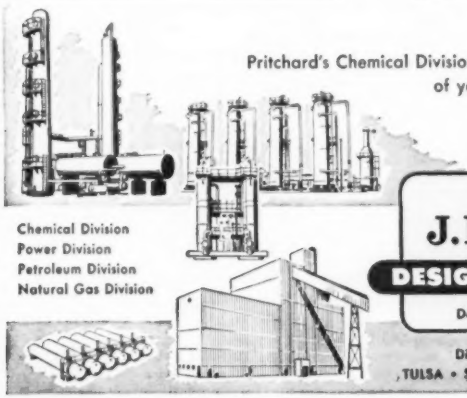

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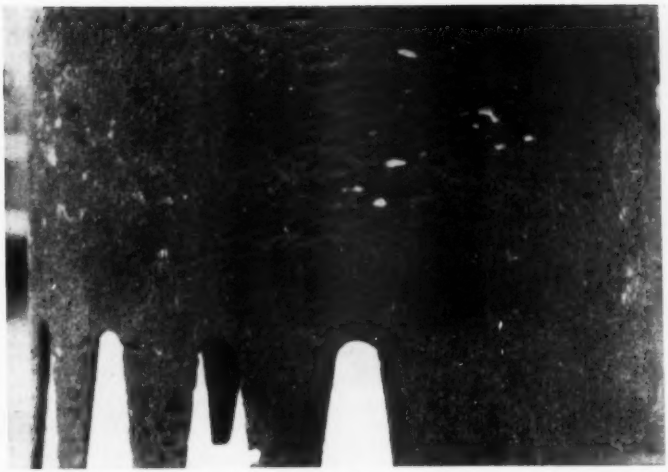
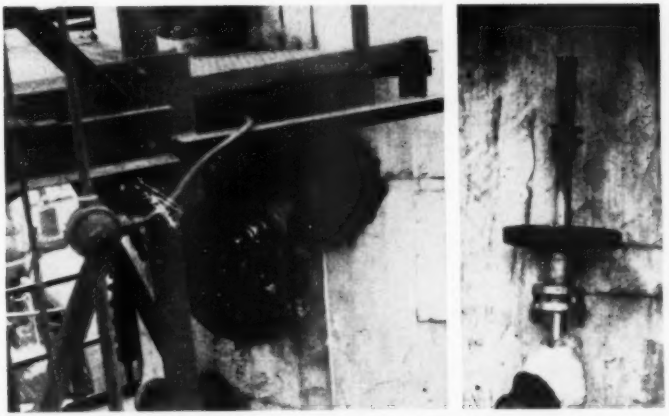


A 12 per cent Cr alloy bubble cap after short exposure to corrosive conditions existing in a secondary tower.

Low-Temperature Corrosion in a Crude-Distillation Tower

by T. N. Griswold*

Low-temperature corrosion can be extremely troublesome when not combated with all practical measures, and may be more costly than many of the more publicized high-temperature corrosion difficulties in crude-oil distillation



Test coupons, installed in the holder, right, are placed into or withdrawn from the tower as desired without shutdown or violation of safety rules. The holder is placed in the tower through a special opening. A view of the holder installed in the special opening is shown, left.

FREQUENTLY topping-unit distillation columns are costly maintenance items for refiners, especially in the cooler areas near their top portion where the lightest ends go overhead. A prime example of this is Continental Oil Co.'s No. 5 crude-topping unit in its Ponca City, Okla., refinery. This unit includes a crude or primary tower, from which overhead product is charged to a secondary or "gasoline" tower. From the top of this latter tower straight-run gasoline and lighter is taken. Corrosion has been severe on the top several trays of this gasoline tower. Between shutdowns, the corroded condition of these internals causes some loss of efficiency of fractionation.

Corrosion Causes

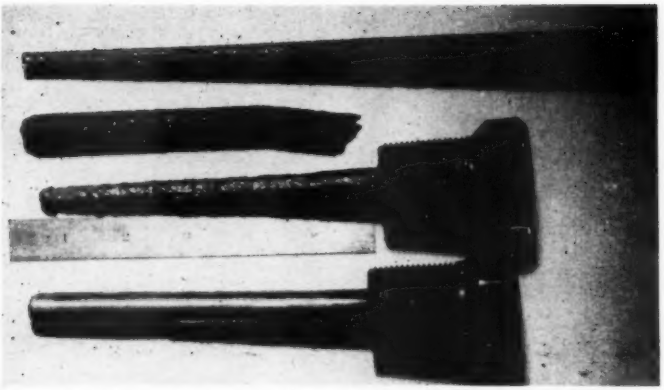
This attack on metals of the tower's internals is a below-dew-point phenomenon where water is condensed to form the basis for corrosive aqueous solutions of salts and acids. Together with temperature and velocity conditions prevalent, this water condensate combines in an accelerated destruction of trays and tray parts. Bubble caps and risers are corroded most seriously, but weirs, downcomers, support rings, and trusses ultimately become affected. The number of trays affected varies according to the desired end point of the overhead product for the period in question.

A high tower-top temperature confines the difficulty to the topmost functioning tray, but lowering the temperature may result in corrosion occurring on several of the top trays simultaneously. The main cause of damage is believed to arise from hydrochloric acid formed in the hydrolysis of the various chloride salts in the raw crude. A small amount of HCl may act as a catalyst for what may otherwise resemble, from corrosion-product examination, low-temperature H_2S corrosion, but the attack is much more severe than if only H_2S were present.

In addition to HCl, H_2S is also a corrodent in the top section of the tower, since all of this gas released from solution or from chemical breakdown in the processing to that point must pass overhead in the gasoline tower. It is known that oxygen is an accelerant to sulfide corrosion and is present in the tower. Possible sources of oxygen are from contacting aerated pond water in the desalting operation, from the process steam, and from solution in the crude oil itself while in storage.

Free CO_2 is evolved from these crude oils on heating. The free CO_2 gas may hasten the erosion-corrosion at points of high velocity. There may even exist a very small amount of naphthenic acids; but these latter two chemicals are not considered to be the chief offenders.

*Metallurgist, manufacturing department, Continental Oil Co., Ponca City, Okla.



Type 304 stainless steel thermowells after 6 months' exposure. A new thermowell is shown for comparison.

TABLE 1—OPERATING CHANGES

Operation	Date of change	Tower-top temp. (°F.)	Other conditions
A	September 1947	250	
B	April 1949	240	
C	May 1949	240	Desalter added
D	July 1949	240	Ammonia-injection point switched to tower feed by stages
E	October 1949	240	Ammonia split between tower feed and overhead line
F	October 1950	195	Side-cut drawoff of 5,000 bbl. reforming naphtha
G	July 1951	195	Throughput to unit lowered to 12,000 bbl. daily
H	December 1951	220	

Operating Conditions

The conditions of operation, which can be called Case A, are:

Tower feed, bbl. per day	8,000
Overhead product, gross, bbl. per day	8,000
Refluxed to tower top, bbl. per day	4,200
Tower-top temperature, °F.	250
Pressure, psig.	15-20
Stripping steam to tower, lb. per hr.	5,500

Table 1 shows the changes in these conditions which are believed to affect corrosion in the tower.

Initially, cast-iron trays and tray parts were used for years throughout the tower in a different service, but the top six trays were replaced with 12 per cent chrome material in December 1947. These trays were removed as junk 9 months later because of severe pitting attack. At this time, a more critical appraisal of this situation was commenced. The result was the installation of six all-monel trays and a monel strip lining on the side walls of this length of tower.

The monel lining was necessary to preclude bimetallic corrosion of the shell proper as well as to guard against general thinning. Monel had been found by a coupon test to be considerably better than steel. The trays were of pressed type, 16-gage caps and risers and 14-gage tray parts. This installation of December 1948 was followed by an inspection in May 1949, which disclosed the topmost tray to be badly attacked, although the remainder was only slightly etched. Table 2 is a condensed summary of conditions found and repairs made during this period.

TABLE 2—INSPECTIONS

December 1947—12 Cr trays installed at top six locations.
September 1948—All top six trays removed since badly corroded. Replacements not yet delivered. Side walls of this location partially strip lined with monel.
December 1948—Six monel trays installed. These were 16-gage caps and risers and 14-gage trays and tray parts. Monel lining completed.
May 1949—Top tray found seriously corroded. Bubble caps lost 0.06 in. and tray lost 0.03 in. Other five trays only slight etching seen.
September 1949—No change in appearance.
April 1950—Top three trays now need maintenance.
August 1950—Top three trays very bad shape, two more trays need maintenance.
February 1951—Top tray, rebuilt tray from old monel parts. Second tray, same as top. Third tray, new monel tray of 12-gage caps and risers and 10-gage tray and parts. Fourth tray, same as top tray. Fifth tray, new carbon-steel tray, 10-gage caps and risers, and ¼-in. tray and parts. Sixth tray, same as fifth tray.
August 1951—Shell corroding below monel strip lining. Several bubble caps replaced on old monel trays. Carbon steel bubble caps pitted in fifth and sixth trays. Third tray excellent condition.

Corrosion Tests

Corrosion tests were conducted in conjunction with the study of this problem. These were made at different times under different operating conditions and are shown in Table 3.

These corrosion rates were developed by means of a corrosion-testing device with which it is possible to immerse metal coupons into the liquid of the top tray and to remove them later during operation while conforming to safety regulations. A long stuffing box insures rigid positioning of the coupons in the tower. The opening in the tower is so placed as to hold the coupons in the liquid without contact with metal parts.

Sufficient turbulence of the flowing fluid in the vicinity of the adjacent bubble caps is believed to establish the type and amount of corrosion on the coupons as found on the tray components. The computed penetration rates of metals tested were believed to establish the relative merits of different metals fairly accurately and to be a least a guide to current rate of losses for the period in question. One weakness of the tests is the inability to show pitting tendencies accurately. The testing location was changed from the top tray to the third tray from the top February 1951, since a liquid level could be held reliably for some time at that location.

TABLE 3—CORROSION TESTS

Test No.	Date	Operation	Length of test	Metals exposed	Corrosion rate, inches penetration per year
1	December 1948	A	15 days	Steel	0.053
				Monel	0.033
2	April 1949	B	15 days	Steel	0.118
				Monel	0.0086
3	May 1949	C	15 days	Cast iron	0.0360
				Monel	0.0150
				Steel	0.0505
				Ni-resist	0.0153
4	July 1949	D	7 days	Steel	0.0592
				Monel	0.0092
5	August 1949	D	7 days	Steel	0.0361
				Monel	0.0130
6	August 1949	D	7 days	Steel	0.0039
				Monel	0.0054
7	April 1951	F	15 days	Steel	0.0202
				Monel	0.0085
8	September 1951	G	15 days	Steel	0.0972
				Monel	0.0106
9	January 1952	H	15 days	Cast iron	0.0515
				Steel	0.0545
				Monel	0.0033

Desalting

Crude oil desalting, using the electrostatic method, was started in May

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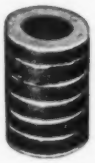

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of 1949. Effort was made to correlate crude pH with the optimum amount of caustic solution injected into the desalter wash water. "Crude pH" in this case is taken by mixing and heating a thiefed sample of crude and distilled water in a standardized way and the separated water checked for pH. For very acid crudes, as low as 3.8 pH, as much as 15 lb. of caustic per 1,000 bbl. of charged crude oil may be necessary, but other crudes may require little or no caustic.

Operators on the unit, with advance information on pH of crude oil to be charged, can anticipate roughly the necessary caustic solution as tanks are switched. Since this is only an approximation, other things must be watched for good desalter operation such as desalted crude pH, wash water effluent pH, and pressure drop across emulsion valve. A too highly alkaline water will cause carbonates to precipitate in this valve or may result in sludge formation in the desalter sphere. Some Kansas crude oils have been found to contain free carbonates or contaminants deliberately added at the wells such as HCl or CCl_4, all of which complicate processing at the topping stills.

Desalting the crude charge has several obvious advantages in operation and likewise from the corrosion standpoint. Removal of 90 per cent of the contained salt does not necessarily mean, however, the remaining salts will cause only 10 per cent as much damage in the fractionating towers.

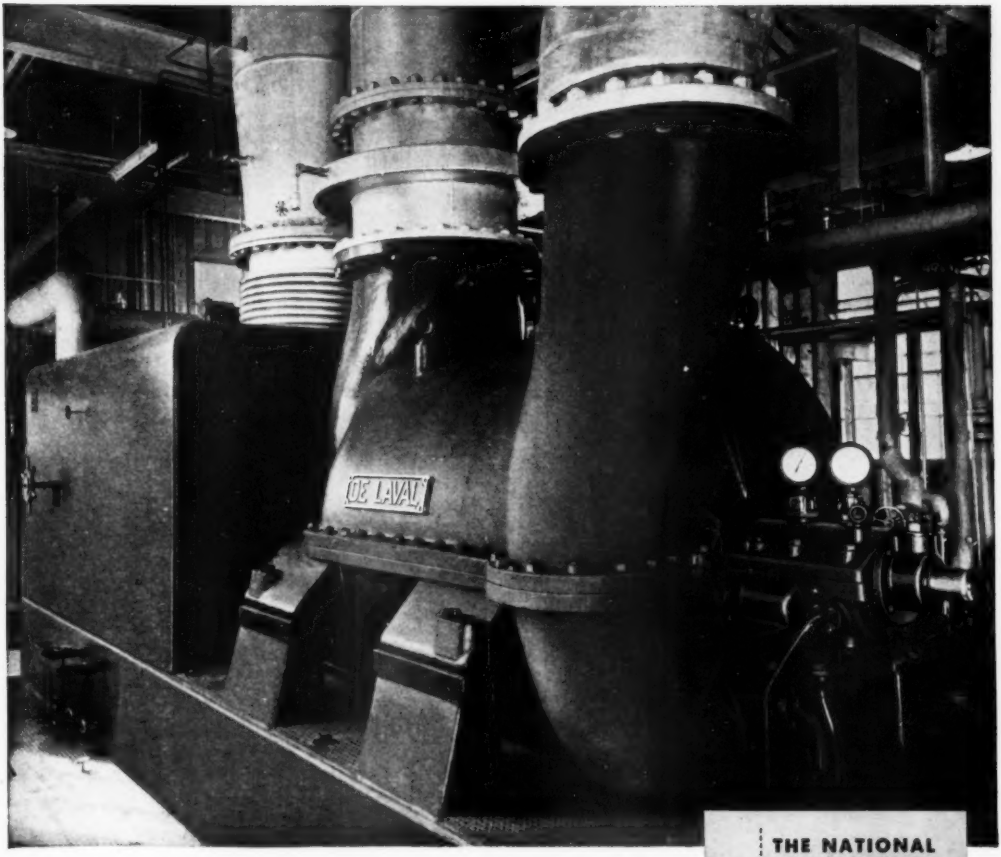
Ammonia Injection

Ammonia had been injected as a gas into the gasoline tower overhead line from the 1947 startup for neutralizing the acidic gasoline stream as it passed through the admiralty condensers. After numerous difficulties with these condensers, both from steel corrosion and brass cracking and corrosion, a series of refinements in the ammonia-injection technique were effected. The amount was eventually controlled manually by the operators by the control-board rotameter to conform to a reflux drum water drawoff pH kept between 7.2 and 7.4. This pH was continuously and automatically recorded, and the recorder reading was checked several times daily against an external pH instrument.

Ammonia requirements dropped about 50 per cent after the desalter came on stream. The total amount of NH_3 required still varied considerably but roughly conformed to 2 lb. of NH_3 for 1,000 bbl. of crude charge per day except for those periods of upsets in other parts of the system such as desalter troubles, as mentioned before.

Use of an alkaline chemical as a neutralizer in the tower was impossible prior to desalting, as the resulting salt formation would quickly plug the tower. It was believed

(Continued on page 255)



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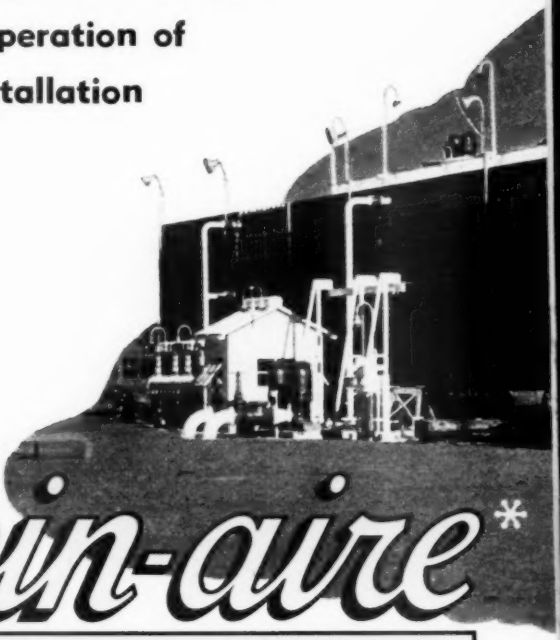

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When water in good quantity and quality is not available the COMBIN-AIRE has manifest advantages over any alternative combination of cooling equipment.

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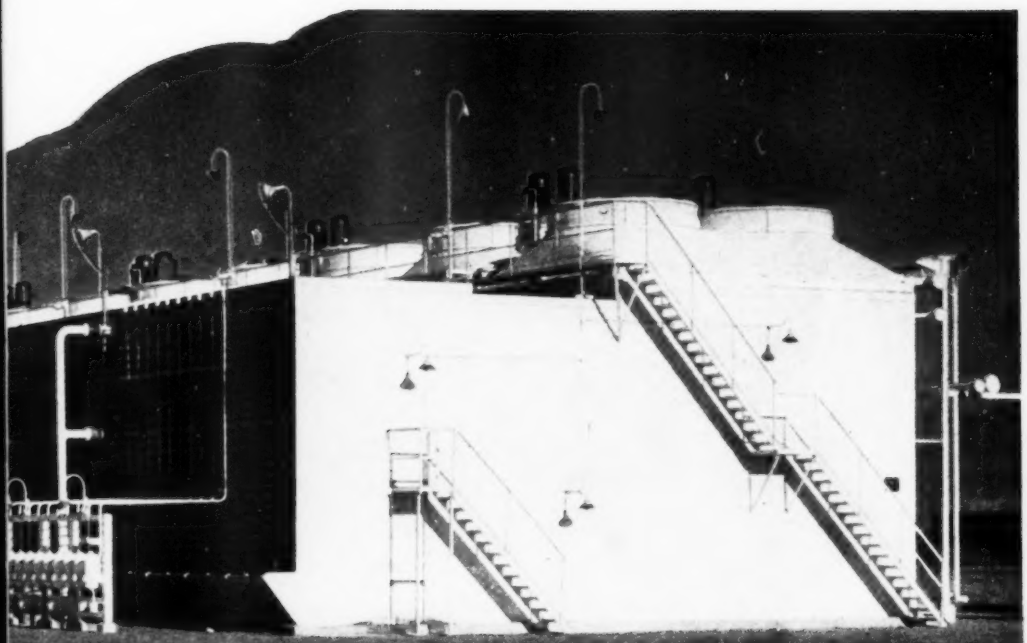
* The COMBIN-AIRE unit is protected by United States patents



This COMBIN-AIRE unit operated by the Plymouth Oil Company in their Sunnyside plant at West Texas discharges heat from oil absorption and fractionation plant streams, a total heat load of about 70 billion B.T.U. per hour.

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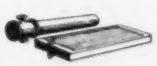

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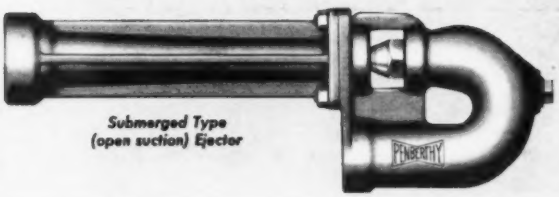

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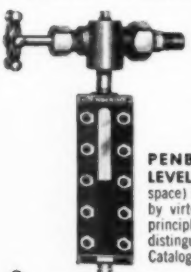

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that at least some ammonia could be used safely in the tower feed after the desalter went in; and because tower-top protection was so urgently needed, a testing program was inaugurated as shown in Tests 4, 5, and 6, Table 3.

A second rotameter with hand control knob was put on the control panel to allow ammonia to be cut into the tower. In each case where the NH_3 to the tower was increased, pressure drops through the tower were watched to detect incipient salt fouling. With no salt fouling when the total NH_3 was put into the tower proper, it was hoped that this amount could be either continued or at least the major portion continued into the tower. In Tests 4, 5, and 6, it was noted that, within the limits of experimental error, the more NH_3 going into the tower, the more the corrosion was reduced. Concluded also from this series of tests was that steel had a reasonable chance of good performance under these conditions.

It was found somewhat later, however, that with the total NH_3 requirement going into the tower feed, the tower become plugged; and this gas had to be switched back to the overhead stream while the tower was washed out. As the desalting technique was studied and smoothed out to some extent over the following months, it was found that some ammonia could be safely used again; and eventually a policy was agreed upon wherein the neutralizing gas required was split 50-50 between tower feed and overhead vapor.

This is seen in operation E, Table 1. Occasional water washings were still necessary to dissolve out the ammonium chloride salts.

In operation F, tower top-temperature was lowered to about 195° F., which spread the corrosive water condensation conditions over several trays. A sizable reforming naphtha side cut was taken out of the tower about the same time, aggravating this condition.

In the February 1951 repair work, the new monel tray was purchased as a test on the premise that monel is the most economical alloy for the service in view of its relatively lower rate of loss, provided it was thick enough at the start.

Conclusions

From observations to date, it is believed that heavy maintenance expenditures will be held down since the ammonia injection and crude desalting are carefully operated. The most economic material for internals is apparently monel, but it is not currently available as tray material. The austenitic stainlesses, including Types 304 and 316, have shown negligible losses in coupon tests, but experiences with Type 304 thermowells in this environment cause suspicion that pitting will be excessive. To go higher in chrome, nickel, and moly content would be very costly.

Cast iron as replacement material offers several advantages. From observations of corrosion on cast iron below the top six trays, it is uniformly corroded graphitically, is free from pits, and its greater thickness portends a much longer life than for steel.

Experience with this tower points out how low-temperature corrosion can be extremely troublesome when not combated with all possible practical measures. Such problems require continuous study, and they may be more costly than many of the more publicized high-temperature corrosion difficulties commonly encountered in crude-oil refining.

BOOKS

TRIAXIAL TESTING OF SOILS AND BITUMINOUS MIXTURES. Published by American Society for Testing Materials, 1916 Race Street, Philadelphia. 310 pp. $3.50.

This extensive 13-paper symposium is designed to bring out some of the current thinking on the subject. The book combines papers and discussions sponsored by A.S.T.M. Committee D-4 on Road and Paving Materials. The word "triax.al" is applied to a form of mechanical test under which a load is applied axially to a cylindrical specimen, while a supporting pressure is maintained against its sides by water, air, or other means. The papers in the symposium were presented at the Pacific area national meeting of the society at San Francisco and at the annual meeting in June 1950.

NUMBER SEVEN

TALKING OF PIPES

from "The Pipe Book" by Alfred Dunhill

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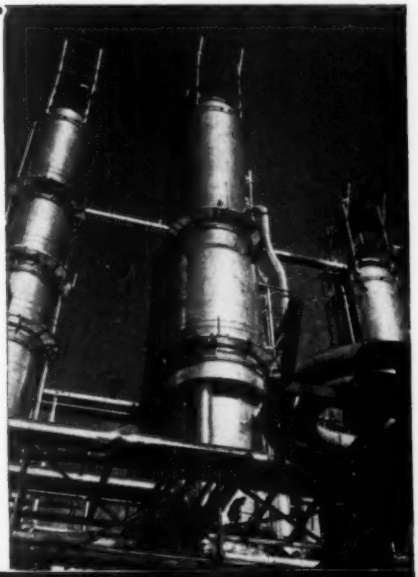

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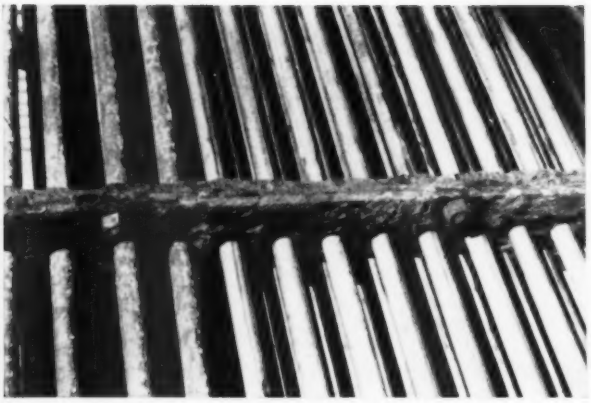

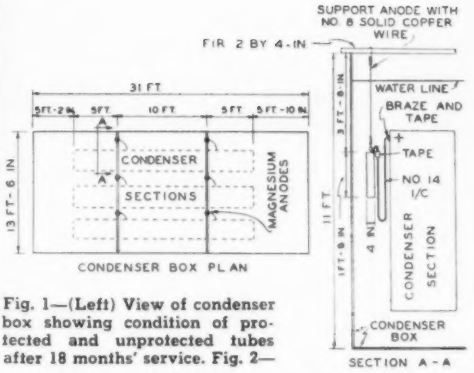

Fig. 1—(Left) View of condenser box showing condition of protected and unprotected tubes after 18 months' service. Fig. 2—(Above) Anode installation for condenser-box test.

Applications of Cathodic Protection . . .

. . . to control refinery corrosion

Here are some practical suggestions on how to adapt an old and proven technique to new uses

V. W. Hatchett*

CONTROLLING corrosion of refinery equipment is an old and ever-present problem throughout the petroleum industry. Damage to process equipment from the corrosive action of the materials being processed has been studied intensively for many years and there are numerous corrosion-resistant alloys available to combat process corrosion when their use is economically justified.

Corrosion of equipment by refinery water streams has received less attention than process corrosion because the rate of metal loss is relatively slow and because it is rarely economical to install alloy equipment to resist water corrosion. Except in special cases, the principal tool used to combat water corrosion has been water treatment. A second protective tool which has been less widely used, but is broadly applicable to refinery water corrosion problems, is cathodic protection. This technique is widely used in the protection of crosscountry pipe lines and for the protection of municipal water tanks, but has been used infrequently for the protection of refinery equipment (Ref. 1 to 7, 9).

*Corrosion engineer, Technical Department, Socony-Vacuum Oil Co., Augusta, Kans.

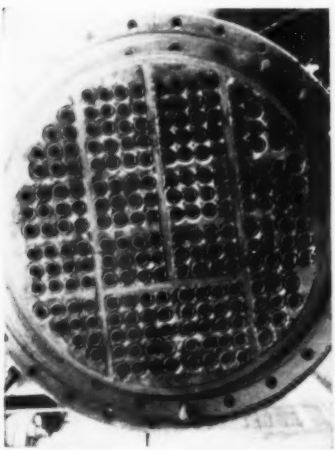

Fig. 3—Electrolytic action of copper-alloy tubes on ferrous tube sheet resulted in severe corrosion to tube sheet; remedy is shown in Fig. 4.

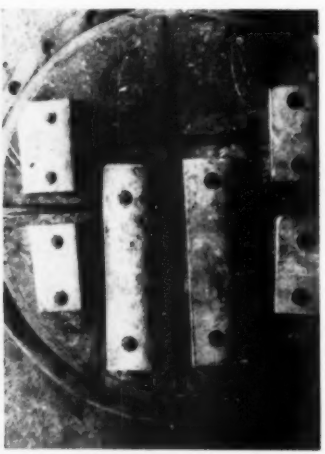

Fig. 4—Magnesium anodes attached to channel cover reduced corrosion rate on tube sheet. No appreciable corrosion has occurred in 3½ years.

Sacrificial Anodes

The most commonly used method for obtaining cathodic protection for corrosion control is the sacrificial anode procedure. This consists basically of selective or controlled corrosion in which the desired protection of equipment is achieved by introducing a metal into the system which is more susceptible to corrosion than any of the metals which it is desired to protect.

TABLE 1

Common Metals and Alloys in Decreasing Order of Their Tendency Toward Electrochemical Corrosion*

Magnesium	Inconel (active)
Magnesium alloys	Brasses
Zinc	Copper
Aluminum 2 S	Bronzes
Aluminum 17 ST	Copper-nickel alloys
Steel or iron	Monel
Cast iron	Nickel (passive)
Chromium-iron (active)	Inconel (passive)
Ni-Resist	Chromium-iron (passive)
18-8 Cr-Ni-Fe (active)	18-8 Cr-Ni-Fe (passive)
18-8-3 Cr-Ni-Mo-Fe (active)	18-8-3 Cr-Ni-Mo Fe (passive)
Nickel (active)	Graphite

*References 8 and 10.

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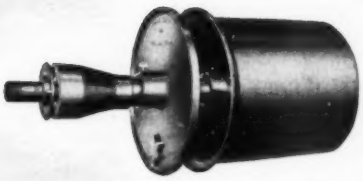

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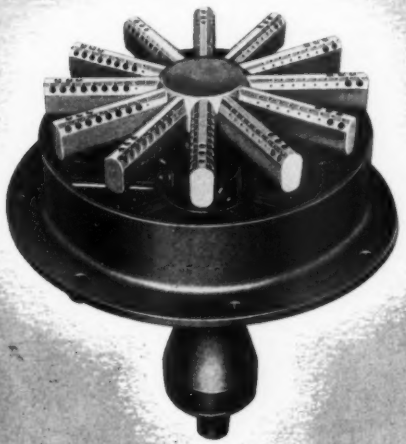

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Fig. 5—Severe corrosion caused failure of this bronze pump impeller after 4 years of service.

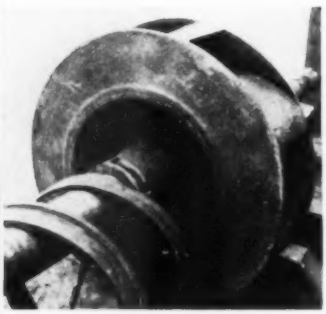

Fig. 6—The water-pump impeller (Fig. 5) was installed in a cast-iron case with stainless-steel plated shaft and bronze wear rings.

Table 1 lists some of the common metals and alloys in order of decreasing tendency toward electrochemical corrosion. This listing is known as the galvanic series, shows the position of some of the common metals and alloys with respect to each other for a sea-water environment. When any two or more of these dissimilar metals are in electrical contact in an electrolyte, the higher ranking metal in the series will generally be selectively corroded while the lower ranking metals will be protected from corrosion. The composition and concentration of the solution, temperature, and other environmental conditions may change the order in the table, although the order shown generally holds for waters encountered in refinery cooling systems.

Thus, in the presence of mildly corrosive electrolytes, such as cooling-tower water, equipment constructed of iron and copper alloys can frequently be protected from corrosion by connecting the iron and copper alloy parts to a magnesium anode which is immersed in the water along with the protected parts. Magnesium, being higher in the galvanic series than either copper or iron, is corroded while giving protection to the iron and copper. This protection lasts only as long as an effective amount of magnesium remains. When the magnesium is depleted corrosion will commence on the next highest ranking metal in the galvanic series, which in this case is iron.

The electrochemical explanation for the protective action of the sacrificial anode is that the anode metal supplies electrons to the metal being protected. The corroding or anode metal goes into solution as a compound of that metal. If the flow of electrons from the corroding metal to the protected metal is large enough to maintain the entire surface negative to its environment, then corrosion generally will not occur on the protected metal. Therefore, from the electrochemical viewpoint, the corrosion-protection function of a sacrificial anode is to supply a stream of electrons to the metals which are to be protected. The current value varies with environment, from .1 to 15 ma. per sq. ft., but in general is of the order of 3 to 5 ma. per sq. ft. Enough sacrificial anode surface is used to give the required amperage for protection. This function of supplying electrons can also be achieved in a nonsacrificial manner by means of forced drainage or induced-current anodes, which is discussed later in this article.

In selecting a sacrificial metal, it is desirable to find the best compromise between completeness of protection and anode life. Both zinc and magnesium anodes were tested in this work. Zinc anodes were used to protect shell-and-tube gas-oil coolers and underground cast-iron water lines. While it was expected that zinc anodes would last longer than magnesium, it was found that for the particular conditions prevailing, the zinc became coated with products of the corrosion reactions to such an extent that their effectiveness was lost in about 30 days. Since magnesium anodes remained active without cleaning under all service conditions encountered in the refinery, the use of zinc was discontinued in favor of magnesium for all sacrificial anode installations. The analysis of the particular magnesium anode used in this work is given in Table 2.

TABLE 2—MAGNESIUM ALLOY

Aluminum ((average) per cent	6
Manganese (min.) per cent	.18
Zinc (average) per cent	3
Other impurities (Si, Cu, Fe, etc.) per cent	.7

Magnesium anodes have been used successfully in protecting underground oil and water lines, box coolers, shell-and-tube coolers, water pumps, an absorber tower and trays, and various water tanks. In all cases the initial rate of dissipation of the magnesium was relatively high, but generally decreased with time. This decrease in rate of loss of magnesium was accompanied by formation of a thin film of magnesium and calcium carbonate and oxide scale on the protected surfaces. This scale or film forms initially nearest the anode and gradually spreads over the entire protected surface. The scale or film formed is so thin as to have no appreciable effect on the heat-transfer coefficients. It is bound so firmly to the metal surfaces that even moving parts, such as pump shafts and impellers, retain the protective film.

As the carbonate scale spreads from the immediate vicinity of the anode, electrical resistance of the scaled surface increases and thus promotes better distribution of the protective cur-

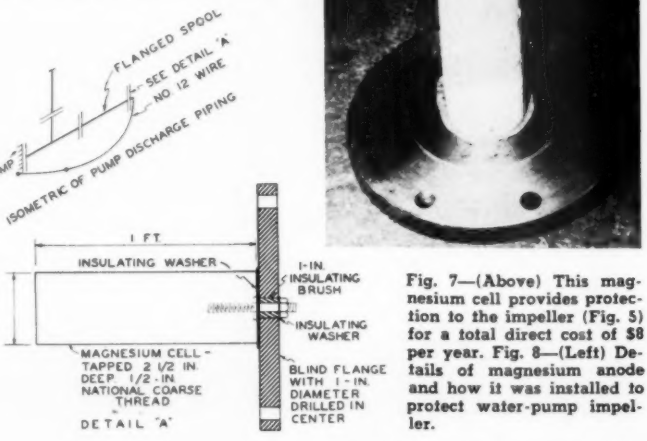

Fig. 7—(Above) This magnesium cell provides protection to the impeller (Fig. 5) for a total direct cost of $8 per year. Fig. 8—(Left) Details of magnesium anode and how it was installed to protect water-pump impeller.

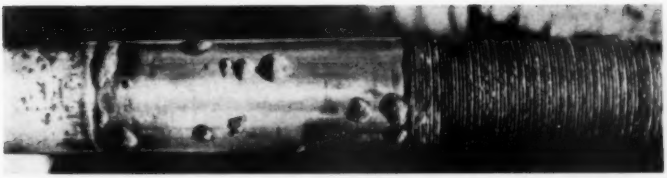

Fig. 9—Chrome-alloy plated shaft for vertical water pump with cast-iron case and bronze impeller. Failure occurred in 18 months.

rent to equipment farther away from the anode. It has been observed that magnesium anodes will protect equipment within a radius of 5-10 ft., depending upon chemical composition of the water, water temperature, and conductivity of the water.

Paints and similar protective coatings may be used in conjunction with cathodic protection with good effect. Inhibitors for water corrosion control also may be used with cathodic protection to the mutual benefit of both agents as corrosion-control methods. The life of the anodes and their effective radius is substantially increased with the use of paint and/or inhibitors.

Case Histories—Sacrificial Anodes

The following specific case histories illustrate the broad field of usefulness of the sacrificial anode technique in protecting refinery equipment.

Case 1.—The typical submerged cooler bundle used in this study was made of inhibited admiralty tubes, 2 per cent nickel cast-iron tube sheets, cast-iron heads and a low-carbon-steel framework. The iron framework was initially coated with a coal-tar paint by the manufacturer.

Two identical bundles were selected for the initial test of cathodic protection. Each of these bundles had 8,400 sq. ft. of total surface. One bundle was protected by use of a 16-lb. magnesium anode. The second bundle was unprotected. Mill scale and coal-tar paint increased the electrical resistance of the surfaces of both bundles. This resulted in better current distribution in the case of the protected bundle and resulted in increasing the severity of corrosion in the unprotected bundle.

The protected bundle showed little corrosion after 18 months; the unprotected one was severely corroded. (See Figs. 1 and 2). Average direct cost for providing cathodic protection to a bundle this size was $25 per year for labor and materials.

Case 2.—In this study the typical closed cooler used was made of inhibited admiralty tubes, heads of steel or cast-iron, tube sheets of 2 per cent nickel cast-iron.

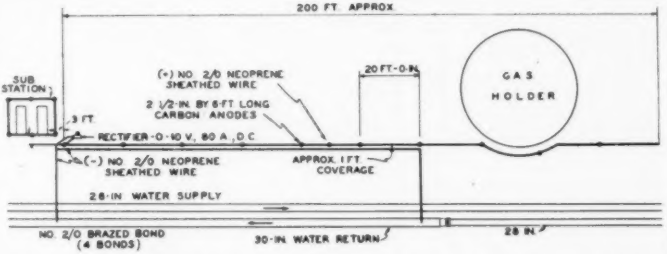

Fig. 11—Layout of equipment for induced current anode method for protecting refinery lines.

Fig. 3 shows the tube sheet of a 675-sq. ft., 26-in. diameter, naphtha cooler which was severely corroded. Near the tubes the plate was corroded as much as 1¼-in. deep due to the electrolytic action of the copper alloy tube on the ferrous tube sheet. Most of this corrosion took place in an 18-month period.

With the application of cathodic protection by means of magnesium anodes, as shown in Fig. 4, no further appreciable corrosion has occurred in 3½ years. The higher the water temperature, the larger the amount of magnesium consumed; however, protection was achieved at water temperatures as high as 180° F. Average direct cost for the protection of this cooler was $41 for installation and $37 per year for maintenance.

Case 3.—Considerable corrosion oc-

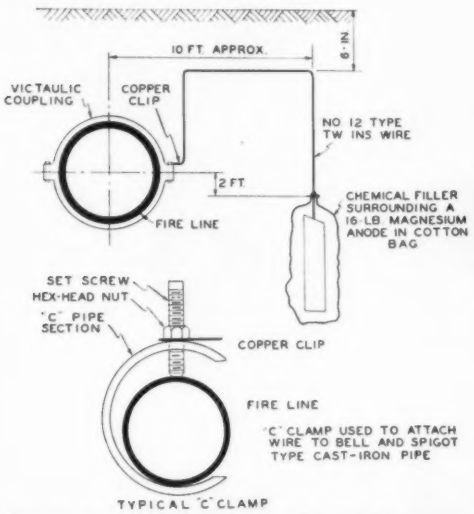

Fig. 10—Arrangement of elements in cathodic protection system for line passing through corrosive area in refinery.

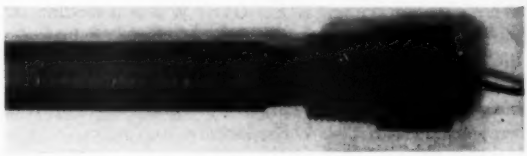

Fig. 12—Photograph of platinum-wire anode.

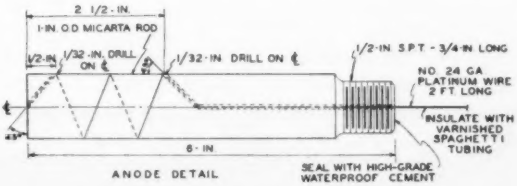

Fig. 13—Details of platinum-wire anode.

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curs on water-pump cases, shafts, impellers, rings, etc., due to the electrolytic action between the different metals present in the pumps. A typical case is that of a water pump, Figs. 5 and 6, which had a bronze impeller, cast-iron case, stainless-steel-plated shaft, and bronze wear rings. This water pump had failed in 4 years due to the severe corrosion of all its parts.

The new pump, with similar metal alloy parts, was given cathodic protection using magnesium. (See Figs. 7 and 8). No measurable corrosion has occurred in 3 years. The cost of protection is $56 installation charges and an average of $8 per year direct charges for labor and material.

Case 4.—Vertical water pumps have been a corrosion problem, as indicated in Fig. 9. Chrome-alloy-plated shafts, cast-iron pump cases, and bronze impellers have caused severe electrolytic corrosion of the different pump parts. Fig. 9 shows a pump-shaft failure after 18 months' service. By connecting a magnesium anode to the pump shaft by means of a sliding contact, the corrosion was stopped. Cost of installation $15, cost of maintenance $8 per year.

Case 5.—Oil and water lines are given cathodic protection in critical cases. A typical example is that of an 8-in. gasoline line passing through an old coke-bed area. After 4 years' service, many leaks developed due to severe pitting all along the line.

The line was renewed in the corrosive area. One 16-lb. magnesium anode was buried 10 ft. from the pipe at 100-ft. intervals (see Fig. 10). After 14 months the line was examined and no corrosion could be observed. This protection was given at a cost of $25 per 100 ft. of pipe per 5 years plus.

Induced Current Anodes

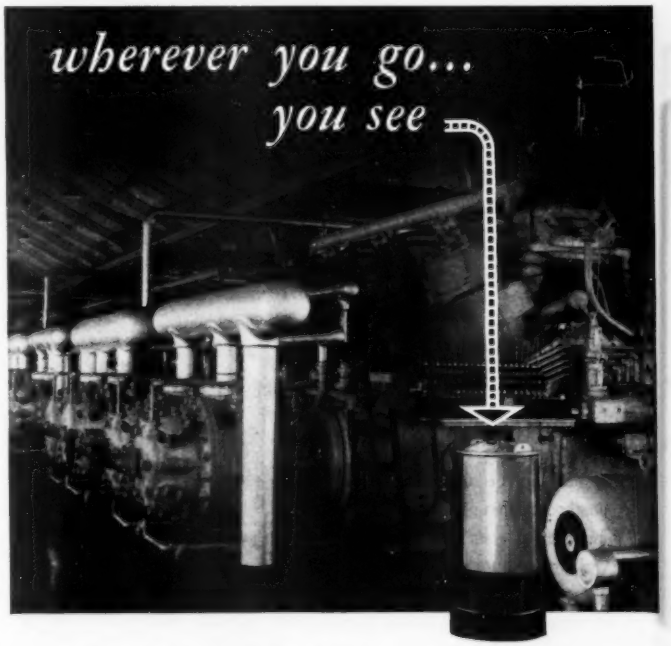
In those cases where the rate of loss of sacrificial anodes is high, permanent or semipermanent cathodic protection may be achieved by using the induced-current method. The principle of this technique is identical with that of the sacrificial anode method previously described. The electron supply for the protected surfaces is obtained by means of a rectifier which induces an artificial d.c. current and voltage difference between the anode and the protected surfaces.

The anode is constructed of materials which are relatively inert to the corrosive effects of the water in the system. Induced-current anodes constructed of carbon and of platinum wire have been used in this work. The choice between the carbon anodes and platinum-wire anodes depends mainly upon the composition of the water. Platinum anodes are preferred in most cases except those involving waters of high chloride (2,000 p.p.m. or more) ion content. Waters of high chloride content corrode platinum at a rate sufficient to make the use of pure platinum impractical. Use of an alloy of 90 per cent platinum and 10 per cent iridium or rhodium in high chloride containing waters may be practical.

Carbon anodes have been used successfully in all types of water encountered in the refinery when the current density is controlled to about 0.25 amp. or less per square foot of anode surface. At a current density of 0.25 amp., carbon anodes last about 2 years. Besides the gradual deterioration which carbon anodes undergo, they also have the disadvantage of being rather fragile and comparatively more bulky than platinum anodes of the same capacity.

In addition to serving as replacements for sacrificial anodes which are dissipated rapidly, induced-current anodes are useful in those applications in which (1) there is insufficient space to install the required amount of magnesium, (2) shutdowns are too infrequent for inspection of magnesium, (3) the available e.m.f. difference between magnesium and the surfaces requiring protection is inadequate to give enough current flow to protect the equipment.

There is no particular limit on the e.m.f. difference which can be employed with induced current anodes, provided anode current densities are not high enough to destroy the elec-



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trodes. In the refinery this voltage rarely exceeds 15 volts and usually 3 to 5 volts is enough.

An application of the induced-current anode technique is the closing of leaks in buried water lines by applying a large e.m.f. difference between the anode and the equipment to be protected (about 9 volts) and high current flow (35 amp. or more). Under these conditions, with waters of high carbonate content (25 grains per gallon plus) the rate of deposition of carbonate scale is frequently great enough to seal fairly large leaks, up to ½ in. Leaks on water boxes also have been stopped as the result of cathodic protection of the coils and the box.

Another feature in the application of cathodic protection is the prevention of bacteriological corrosion of buried metal by sulfate-reducing bacteria. This is described later.

Case Histories—Induced-Current Anodes

The application of the induced current anode method to typical refinery problems is illustrated by the following specific case histories.

Case 6.—Oil and water lines (steel, cast iron, or galvanized) are given cathodic protection in critical cases. A typical example is that of 26 and 30-in. lines carrying cooling-tower water. These lines lay parallel to a spray pond in very conductive soil. Corrosion on the lines was due to induced currents from nearby power lines, local cell action, and corrosion by sulfate-reducing bacteria.

Application of cathodic protection to the lines was made as shown in Fig. 11 using carbon anodes. Initial current used was 31 amp. at 9.7 volts. After 3 weeks, the current was 35 amp. at 9.5 volts. The many water leaks on the line were stopped in 5 weeks; corrosion of the line due to stray currents and chemical and bacterial action also was stopped.

Case 7.—This test was made on four submerged gasoline coolers constructed of inhibited admiralty tubes, nickel-cast-iron tube sheets, cast-iron heads, and low-carbon-steel framework. Severe corrosion was occurring on the ferrous parts. To control the corrosion, eight 16-lb. magnesium anodes were added, two to each bundle. Due to high water temperatures, high chemical content of the cooling water, and highly corroded nature of the surface, these eight electrodes did not give complete protection and the anode consumption was excessive. Observations with a temporary induced current anode system in these coolers showed that 60 amp. of current were required to give the desired protection. This current flow corresponds to $600 per year loss of magnesium. This potential saving in magnesium justified the installation of induced current protective facilities.

Carbon anodes, 2½ by 84 in. were installed for an initial cost for labor and material of $750 and a yearly maintenance cost of $250. This gave satisfactory protection on a continuous basis. Most of the yearly cost was due to excessive current densities (0.5 amp. per sq. ft.) on the carbon electrodes. By doubling the initial number of electrodes and thus decreasing the current density to 0.25 amp. per sq. ft., the life of the carbon anodes was increased at least 2½ to 3 times, which should considerably reduce the annual maintenance and operating cost.

Case 8.—The cooler used in this study was made of inhibited admiralty tubes, heads of steel and cast iron, tube sheets of 2 per cent nickel cast iron. Bundle cooling area was 675 sq. ft.

Initially this cooler was protected satisfactorily with magnesium anodes, but it was difficult to renew the anodes at the proper time.

The six platinum wire anodes (see Figs. 12 and 13) installed have given protection over longer periods of time without attention than was obtained with magnesium. Higher voltages and currents are possible with platinum anodes.

Case 9.—Water pumps have been given adequate protection with magnesium. However, to achieve continuous protection and higher current flow on pumps, platinum anodes with induced current flow are used. A typical

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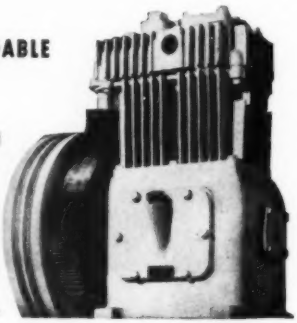

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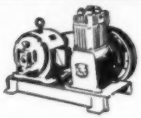

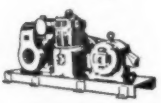

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example is that of a group of eight water pumps which had cast-iron cases, stainless-steel shafts, and bronze impellers and wear rings. Magnesium would last 9 to 12 months.

By using platinum wire anodes in the discharge line of the pumps (see Fig. 12) and a rectifier on the group of eight pumps, continuous protection has been achieved. Based on this experience, new pumps for similar service conditions have been installed with cast-iron impellers and carbon-steel shafts in place of the more costly alloys of copper and chromium.

Economics of Cathodic Protection

During the period that cathodic protection was under active study and being adopted throughout the refinery, there was also continuous improvement and study of water-conditioning practices. Consequently, the observed reduction in expenses attributed to corrosion cannot be assigned exclusively to either of the methods used to reduce corrosion. It is evident that the role of cathodic protection was a major one in the over-all program of corrosion control. Further, the ultimate benefits of cathodic protection have not yet been fully realized.

It is generally possible to justify cathodic protection costs on the basis of immediate reduction in maintenance costs.

A secondary benefit which is expected to become increasingly important is the reduction in the need for alloy and nonferrous metals. While it is too early to evaluate this effect with accuracy, it is evident that it will be economical to replace nonferrous cooling tubes with steel tubes in some services.

Selection of cathodic protection equipment and determination of whether or not a given piece of equipment can be protected by cathodic means is generally a matter of experimentation.

For example, in a typical cracking plant area, it was found that about 60 magnesium anodes were required to give the desired protection of coolers. The installation cost (materials and labor only) per magnesium anode was about $8 or a total of $480 for the entire cracking plant installation. The average life of the anodes was about 1 year. The annual replacement cost was $420.

This installation of magnesium anodes could be replaced by an induced-current anode system. The estimated cost (materials and labor) for replacing with carbon anodes is $2,700 and with platinum anodes is $3,300. The estimated maintenance and operating cost for either type of anode is $150 per year.

While the potential saving in magnesium would not, in this case, justify the expense of installing an induced-current anode system, the assurance of continuous protection of this critical surface justified the modest expense.

Acknowledgment

The successful application of cathodic protection to the refinery equipment at the Augusta, Kans., refinery has resulted from the coordinated efforts of the operating, maintenance, and technical departments. This article represents the contributions of numerous members of the Augusta refinery staff.

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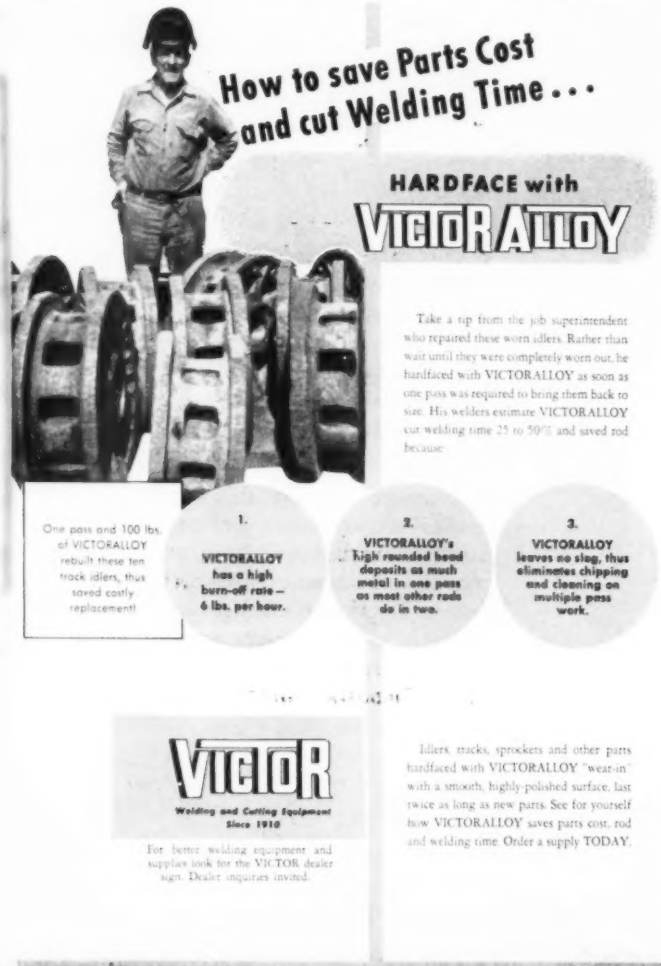
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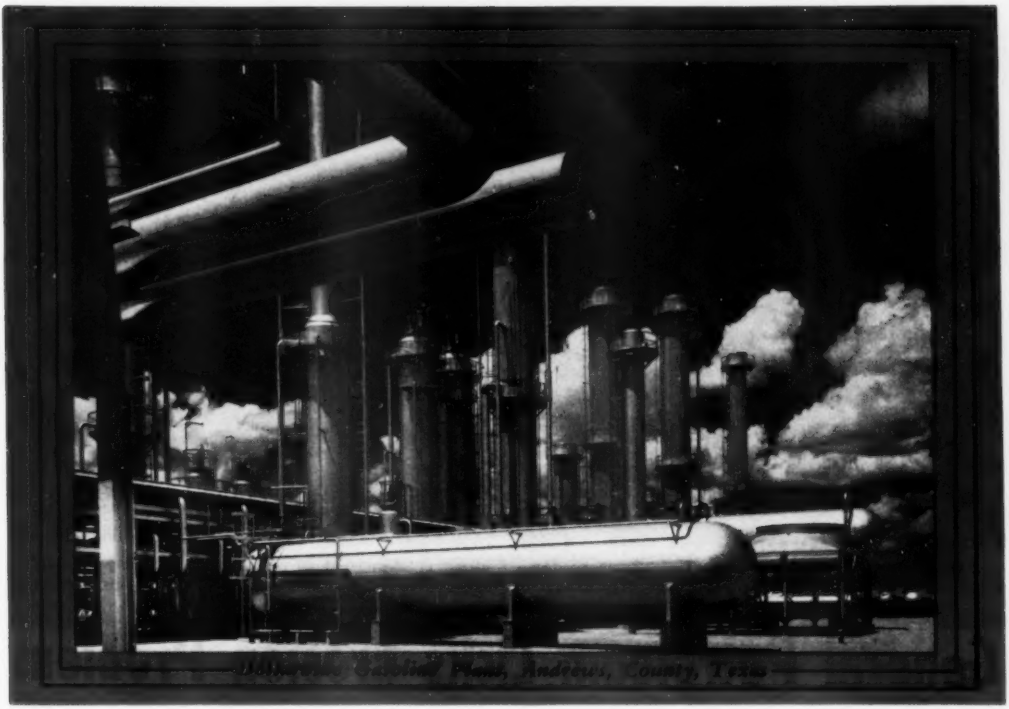

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Two views showing how the pockets or boots were inserted in catalyst lines at points where the lines changed direction. Now instead of catalyst impinging on steel at these turns, beds of catalyst build up to protect the lines.

General Petroleum Licks Erosion Problem In T.C.C. Catalyst-Handling Lines

by D. H. Stormont
West Coast District Editor

WHEN the four Thermofor catalytic cracking units at General Petroleum Corp.'s large Torrance, Calif., refinery were operating with a major overhaul every 12 months, the relatively short life of the catalyst lines, though costly, was not viewed with particular concern. Their repair or replacement was time consuming and expensive, but no shutdowns were caused by failure of a catalyst line.

As the scheduled runs between turnarounds were lengthened—first to 18 months, and then to 24 months—the service life of the catalyst piping became a critical factor in the units' operation.

Catalyst erosion also was causing difficulties in the catalyst kilns; their linings could not withstand its abrasive scrubbing. Another problem, one of normal wear rather than of erosion, involved the bucket-type elevator systems serving the kiln and reactor. Bushing and knuckle wear was causing too frequent replacement of the 570 and 820-ft.-long chains.

Here is what General Petroleum maintenance engineers did to obtain better service from this equipment:

Solving the catalyst-piping problem.—Experience with the carbon-steel piping from the bottoms of the reactor and kiln showed these lines would not safely last for more than 10 or 12 months. While the main concern was with these 12 and 18-in.-diameter lines, smaller lines carrying the catalyst beads downward also had to be replaced or repaired too frequently.

Heavier-walled pipe with deep, frequently spaced sentinel holes, and double-walled details with telltale holes drilled and tapped through the outer shells first were considered. These efforts were unsuccessful.

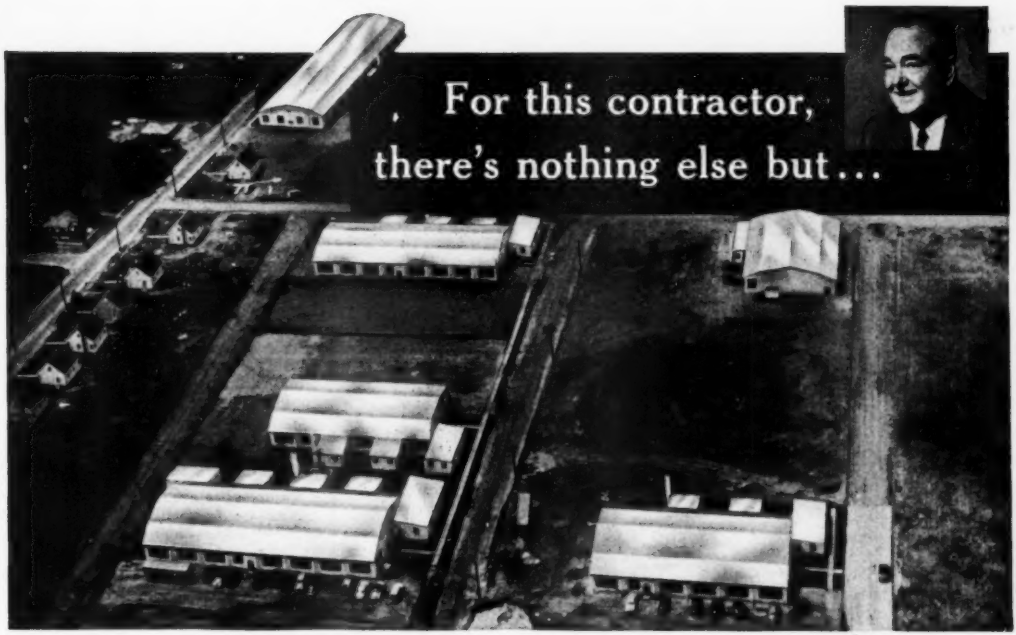
For example, in the case of a double-walled reactor bottoms line, the detail consisted of three layers before replacement could be made. Had the detail remained in service much longer it would have failed through the outer wall. This particular detail had been fabricated with Schedule 80, 12-in. pipe. It had been in service only 8 months before the inner wall had worn through.

Solution to the catalyst erosion problem in small lines was found by inserting pockets or boots at all places where a line changed direction of flow. As shown in the accompanying photographs, these boots were fabricated from pipe of slightly larger diameter than that of the line in which they were placed. Likewise, so that a pocket would be formed in which a bed of catalyst could accumulate, the boots extend beyond the point where a line changes direction of flow.

In the kiln and reactor bottoms lines, partial or full riffles were placed in the details. As in the case of the boots, the riffles result in a back of catalyst beads being built up, causing the catalyst to impinge on catalyst rather than on steel.

Since the reactor and kiln bottom lines do not run full, in most cases the crescent-shaped baffles are sufficient. However, at the reactor bottoms line mentioned above, the detail was fabricated with full riffles to determine if better service could be obtained. In either case the edges of the riffles were built up with hard-facing weld metal.

In the reactor vapor outlet ells, excessive wear also was found to be occurring because of the carry-



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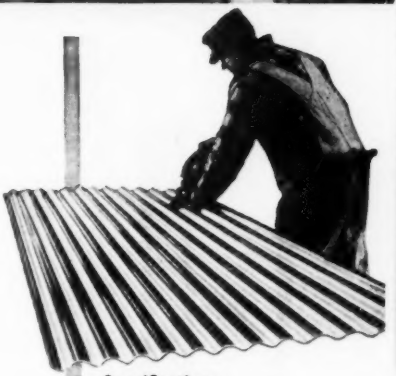

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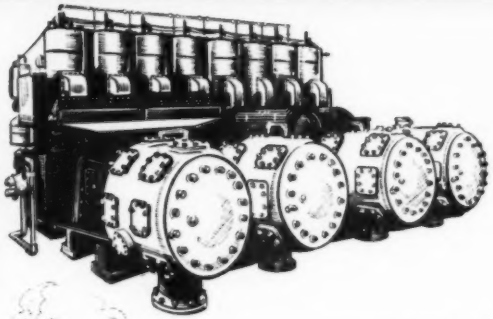

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over of catalyst fines. This situation was improved materially by lining the 12-in. ells with 14-gage, type 410 stainless steel.

Kiln lining erosion. — Circulation of catalyst in the kilns of the four T.C.C. units at times had been interrupted by the insulation breaking off the inside and falling to plug the bottom grids.

In an attempt to protect the insulation, the inside walls of three of the critical zones in two units were lined with 14-gage, type 410 stainless steel. The lining was attached by bolting it to studs which had been resistance-welded to the kiln shell.

The particular zones selected were such that the life and effects of high temperatures on the metal lining could be determined. On a recent inspection of both kilns after a 1-year run, the linings in both units were found to be giving excellent service.

Catalyst elevator chains. — The chains used in lifting the bucket-type elevators have been found to undergo an average annual bushing wear rate of 0.06 in. in kiln service and about 0.08 in. in reactor service. Since a new chain costs approximately $17 per foot, it is well worth the effort to obtain maximum service from a chain.

As bushing wear is the limiting factor in the service life of the chains, the first practice at Torrance was to use the chain until the original bushing was worn 80 per cent. The chain was then rebushed with new bushings and reinstalled in a turned position. The rebushed chain was used until the new bushings had worn 80 per cent, after which it was discarded. This practice resulted in doubling a chain's life, at an added cost of less than one-fourth that of a new chain.

Using the above method, the controlling factor of a chain's life was switched from bushing wear to knuckle wear. To prolong a chain's life still further, General Petroleum started looking for a method of building up the worn knuckles.

Experiments showed that arc welding, using a 5 per cent chromium and ½ per cent molybdenum rod, and heat treating would produce the desired result. The knuckles then were ground to the original contour and the chain rebushed and repinned.

One elevator has this type of reconditioned chain in service. No service records on the chain are available but it is believed that knuckle wear of the chain will be comparable to that of a new chain.

Using both practices, i.e., rebushing a chain once and then reconditioning the knuckles, it will be possible to turn a chain three times after initial usage instead of once as has been the case. Thus sidebar wear of ⅛ in. and one reconditioning now limit the life of a chain.

Reducing Erosion of Coke-Handling Equipment

At Torrance, General Petroleum Corp. also has successfully mitigated two severe instances of coke erosion. One was at the coke-sizing car and the other was in the slurry line which moves the coke from the units to the stockpile.

After the two delayed coking units were placed in operation in 1946, excessively high erosion rates soon were observed in the side plates, crusher rolls, and teeth of the coke-sizing car. Erosion and corrosion rates of 0.02 in. per month were measured on the rolls and even higher rates existed on the teeth. In a very short time the 18-8 stainless steel attachment welds stood out in relief from the cast manganese-steel teeth.

To determine how 18-8 and 25-12 stainless steel would perform in such service, test plates of these steels were installed. A check 6 months later showed the 18-8 steel to be standing up satisfactorily. Accordingly ½-in. wear plates with 18-8 stainless steel facing were installed on the side plates. Likewise two spare rolls were faced with 18-8 weld metal and six stainless cast-steel teeth were installed among the manganese-steel teeth of one roll.

After 13 months of service, no erosion or corrosion could be observed on the wear plates or rolls, or on the six cast-steel teeth. The manganese-steel teeth remaining in the role had lost 35 to 40 per cent of their original metal thickness. On the basis of these results all crusher rolls were rebuilt with 18-8 cast-steel teeth and faced with 10-gage stainless sheet. Erosion no longer is a problem of consequence at the coke-sizing car.

Coke slurry line.—To transport the coke from the coking units to the stockpile, a 4,000-ft. slurry line is used. Carrying coke particles varying in size from fines to egg size, the line was installed using 12-in., 3 gage spiral-welded pipe with Schedule 40 pipe being used at the bends.

After the line had been in operation a short while, it became evident the abrasive coke particles were eroding the line at the rate of 0.25-in. per year. All of the erosion, however, was occurring along the lower one-third of the line. But even by rotating the line 180°, a line's service life was only 20 months.

When it was necessary to replace the line, Schedule 30 pipe was used. With rotation it was expected to give 23 months' service.

Because of this excessive erosion rate, a 12-in., 16-gage 18-8 stainless steel line was fabricated. Installed in August 1949, no apparent wall loss has been observed on the alloy line after 2½ years' operation. A second 18-8 stainless-steel line, required when two additional coke drums were placed in operation 2 years, likewise is showing no wall loss.

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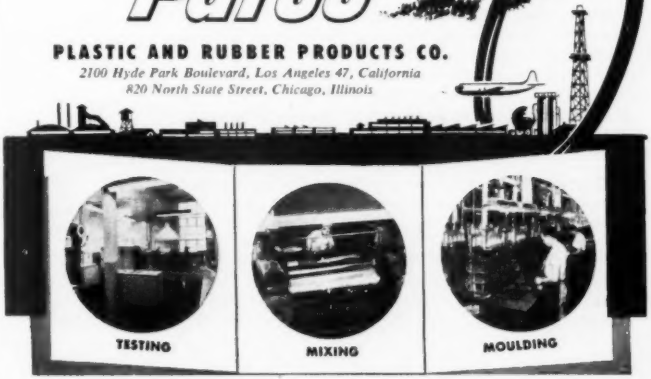

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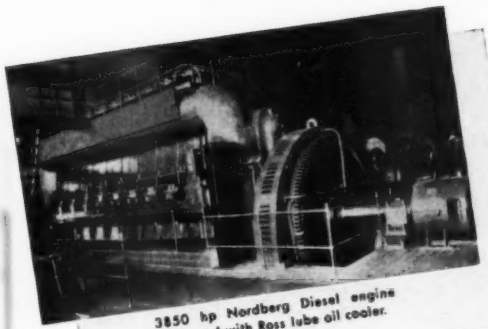
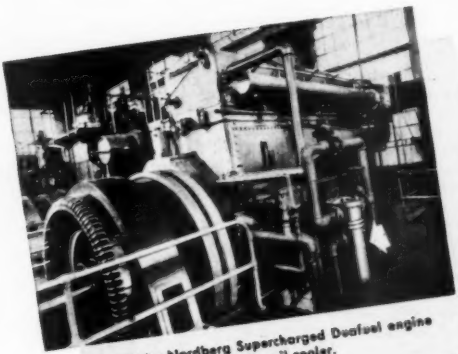


3850 hp Nordberg Diesel engine equipped with Ross lube oil cooler.



1220 hp Nordberg Supercharged Duafuel engine equipped with Ross lube oil cooler.

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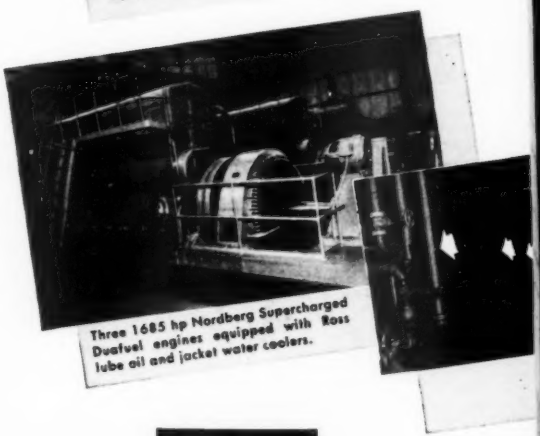


Three 1685 hp Nordberg Supercharged Duafuel engines equipped with Ross lube oil and jacket water coolers.

Fig. 1—Steel water line corrodes after 7 years in brackish-water service.

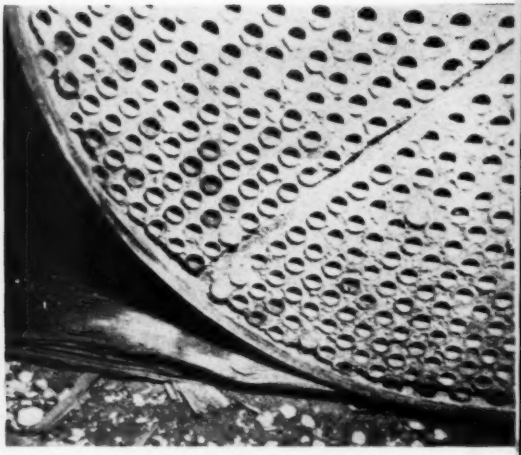


Fig. 2—Repaired tube sheet, cleaned and protected by coating of iron cement.

Cities Service tackles

Brackish-Cooling-Water Corrosion

by J. J. Picarazzi*

CORROSION by brackish cooling water constitutes one of the most serious problems encountered in the operation of the Tutwiler refinery of Cities Service Refining Corp., at Lake Charles, La. The large amount of water handled and the great amount of equipment involved makes cooling-water corrosion the subject of constant attention. Cooling-water flow often approximates 300,000 g.p.m. More than 230 condensers and coolers ranging in size up to units with 18,500 sq. ft. of heat-transfer surface are in service at the refinery.

Refinery cooling-water source is the Calcasieu River which empties into the Gulf of Mexico. The river has been dredged to accommodate ocean-going vessels. Flow of the river is governed more by wind direction and velocity than by rainfall in its water-shed. Its "upstream" flow is frequently recorded. This flow variation results, of course, in changes in the character of the water, especially in its salinity. Water temperature is another variable as are pH values which range from 6.4 to 8.5. Generally, when salinity is high, pH is high; and when salinity is low the pH is also low, the reduction being caused by entrance of acid swamp water into the river. Typical analyses of the water under high and medium salinity conditions are shown in Table 1.

TABLE 1—ANALYSIS OF CALCASIEU RIVER WATER

Temp. °F.	pH	Parts per million: Dissolved solids	Dissolved oxygen	Chloride	Calcium	Methy orange alkalinity	Turbidity as SiO_2
75	7.6	18,034	4.9	8,475	720	77	<25
76	7.7	16,446	4.5	7,763	776	82	<25
69	7.6	20,374	4.6	9,114	772	84	<25
63	7.8	18,382	7.2	9,292	828	96	<25
56	7.3	5,310	6.6	2,428	266	45	45

Since the water system is operated on a once-through basis chemical treatment of the water for corrosion prevention is not economically feasible. However, certain measures have been adopted to render the water less aggressive. First of all the water is cleared of large solid objects by passage through one set of traveling screens and two sets of stationary screens. Cleanliness is an important factor in water corrosion, especially with regard to condenser tubes.

Intermittent chlorination is practiced to control aquatic growths in the water system and boiler blowdown water is injected to raise the pH of the cooling water. Since the ratio of boiler blowdown water to river water is about 1 to 1,000, the pH increase resulting from blowdown water injection is less than 0.5. However, this increase is worthwhile because it costs nothing for chemicals or operation and is accomplished by only a very small temperature increase in the cooling water.

Chlorination has been a very important factor in condenser-tube life. Although it had been practiced on a

*Cities Service Refining Corp., Lake Charles, La.

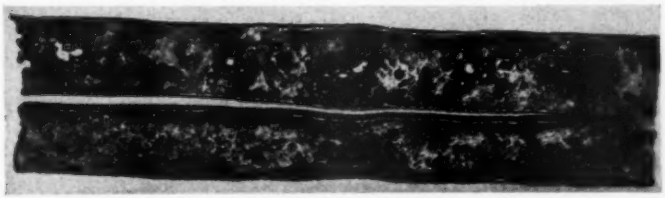


Fig. 3—Concentration-cell corrosion occurs at low-velocity points on water side of condenser tube.

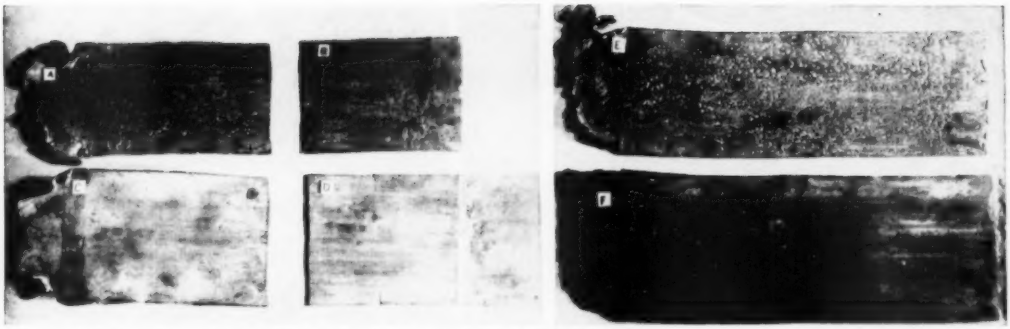


Fig. 4—Aluminum-brass ferrules (A, B, and E) were installed in admiralty tubes (C, D, and F) for 30 months. Areas covered by ferrules were well protected.

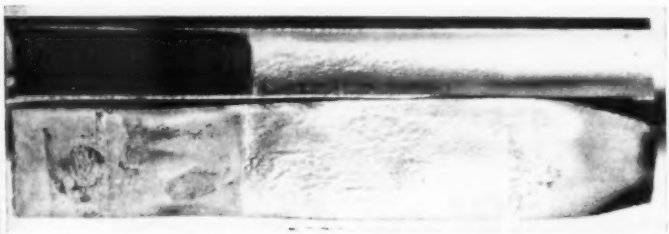


Fig. 5—Impingement attack of 70-30 cupro nickel tube section installed beyond a nonmetallic ferrule.

small scale since the plant was put into operation, serious difficulties were experienced during the summer of 1948 as a result of extensive growths of a hair-like, invertebrate, sessile animal in the water system. Frequent shutdowns of condensers and coolers was necessary to remove from tube sheets mats of this growth, which was erroneously called "seaweed" and later identified as "colenterata." This animal was found growing in all parts of the system available for inspection.

Mats on the tube sheets resulted from deaths of the animals and subsequent sloughing off of their bodies which accumulated at the inlet tube sheets of tube bundles. The blockage thus created not only seriously reduced cooling capacity of the tube bundles, but also led to tube leakage as a result of velocity or "impingement" attack on the few tubes not blocked. In addition, attack on the blocked tubes was accelerated, due to water starvation and increased film temperatures. Increased chlorination was agreed upon as a means of eliminating this growth from the system and was inaugurated with due precautions to avoid excessive kills and immediate blockage of all the condensers and coolers in the refinery. In a few weeks definite improvement was noted and unexpected condenser tube failures were greatly reduced.

At present chlorine is injected under manual control for 30 minutes every 8 hours at a rate to produce 8 p.p.m. above demand about 600 ft. from the point of injection. This usually results in residuals of about 0.2 p.p.m. at the most remote part of the system, which is about 3,100 ft. from the point of injection. This dosage has been sufficient to prevent the growth of colenterata. However, during the summer of 1951, barnacles have been observed in many parts of the system. It is expected that these will be killed by fresh water, which is more prevalent during the winter months.

Vertical-shaft, centrifugal turbine-type 1,200 r.p.m. river water pumps were originally installed in the refinery, which was built during the World

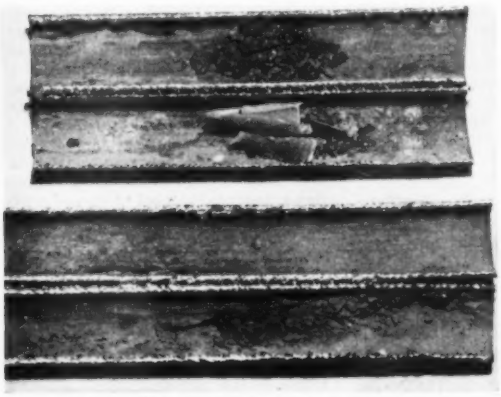


Fig. 6—Enlodged debris in tube sections.

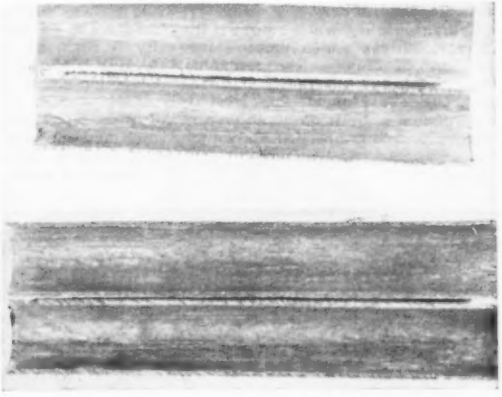
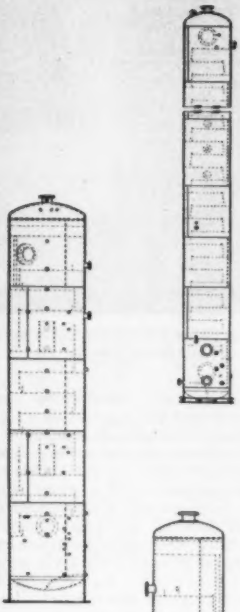


Fig. 7—Same tube sections after cleaning.

Grooving caused by resultant excessive velocity and turbulence conditions is evident.



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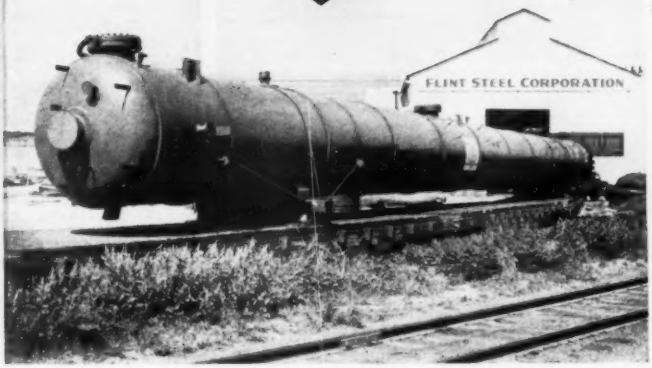

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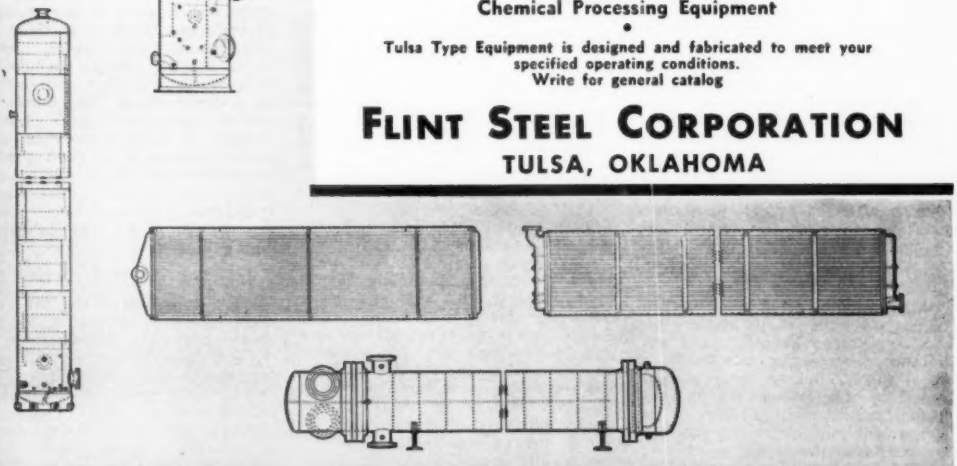

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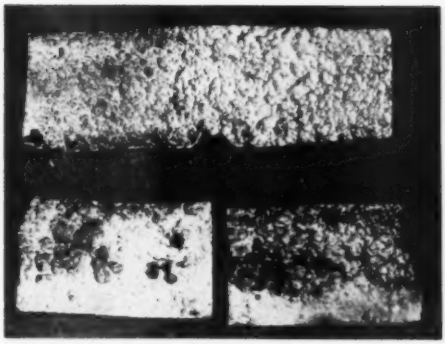

Fig. 8—"Denickelification" of cupro nickel tube. Free copper shows as dark areas.

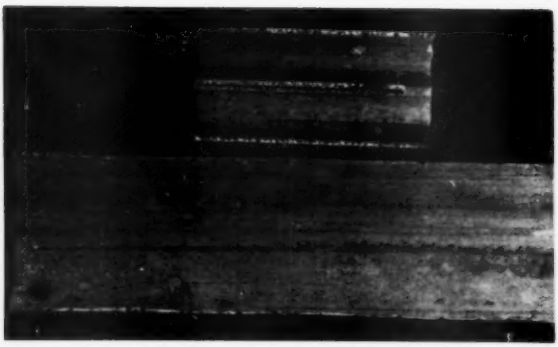

Fig. 9—Alclad tubes in service 30 months show little corrosion, indicating cathodic protection by cladding metal.

War II period when material restrictions were in force. The units are constructed with cast-iron impellers and cases. These pumps were replaced as necessary with bronze. Repairs by brazing made possible use of some of the cast-iron bowls as long as 7 years. The cast-iron impellers lasted only a few years because of the thinner sections involved and the greater turbulence to which they are subjected. Type 316 stainless-steel shafts are being used in these pumps and because of lack of stagnation no pitting or cracking difficulties have been encountered in spite of the high chloride content of the water.

Water mains from the pump house to the process area are 48-in. diameter steel lines about ½ mile in length, coated internally and externally. The internal coating consisted of a coal-tar primer and one coat of coal-tar enamel applied by the "hot spun" method. The exterior system consisted of a coal-tar primer, one coat of coal-tar enamel, and a wrap of 15-lb. coal-tar-impregnated asbestos felt. The system is so arranged that internal inspection of these lines is impossible without shutting down several process units and to date this has not been deemed advisable. However, pieces of tar were found in water-using heat-exchange equipment about 2 years after the plant went into operation, indicating that the internal pipe coating was being lost.

Bottom Line Corrosion

Leakage developed in a few branch lines at junctions where high turbulence exists after about 7 years and an internal inspection was made in one of these branches. In a straight portion of this branch the coal-tar coating was intact in the top 90° of the line and the pipe metal was free from corrosion attack, but the coating had disappeared in the remaining 270° of the line allowing general corrosion and pitting of the steel. Fig. 1 shows a corroded portion of this line. The large hole was made with a cutting torch to facilitate removal of the piece.

The condition found in the branch line aroused concern over the condition of the mains and consideration is being given to the in-place application of a cement mortar lining to the interior of these lines. Spot inspections of the exterior of the mains indicate that the exterior coating system is in good condition and no corrosion was found except at a few field joints which had not been coated.

Tubular Condensers and Coolers

Process condensers and coolers in the refinery are floating head, removable bundle type with at least two passes on the water side, which is usually the tube side of the unit. Thus water contacts the outer faces of the tube sheets and the interior of the channel, channel cover, floating head cover, and tubes. The original equipment for the refinery consisted of cast-iron channels and floating head covers, rolled steel or cast-iron channel covers, rolled steel tube sheets, and 16 gage inhibited admiralty tubes.

The large steam surface condensers installed in the plant were of fixed tube-sheet design. Some of these were equipped with muntz metal tube sheets, others with rolled steel tube sheets. Both cast iron and rolled steel water boxes were used and the tubes were admiralty and muntz metal.

Corrosion damage to this condensing and cooling equipment has been severe and extensive. First signs of damage appeared on the steel tube sheets where galvanic conditions existed due to the presence of admiralty tubes in the sheets. It soon became obvious that unless attack on the tube sheets was controlled, renewal of tube bundles containing good tubes would be necessary because of corroded tube sheets. Several organic coatings were tested with no success.

The water faces of a few tube sheets were covered with a deposit of lead, via welding, but it was difficult to obtain a pinhole free deposit and accelerated attack occurred at these pinholes in the lead, which is cathodic to steel in brackish water. The most effective and economical method found was the application of a commercial, iron-cement compound to the tube sheets, usually without removing the bundle from its shell. This cement was applied with a putty knife to the mechanically cleaned and roughened face of the tube sheets after plugging the tubes with corks. The material showed very good resistance to corrosion by the cooling water. When properly applied and allowed to dry before being placed in service, spalling of the material was rare.

Gasket surfaces on steel tube sheets presented another major problem, primarily because a comparatively small metal loss resulted in leakage of the assembly. Also, it is probable that crevice effects accelerated corrosion on these surfaces. The remedy for this trouble was obvious, but expensive. This consisted of removing the bundles to the plant's maintenance shops for chipping or machining the gasket areas, building up these areas with monel weld metal, and remachining. Fig. 2 shows the tube sheet of a bundle, repaired and protected as outlined above. This bundle was retired after over 7 years of service becaues of leaky tubes. The monel gasket surface is in good condition and corrosion on the face of the sheet, though not inconsequential, has not progressed to the point where mechanical strength of the sheet is seriously impaired.

Tube Sheet Materials

When condition of the tubes warrants rebuilding a bundle, the tube-sheet material specifications are changed to provide a corrosion-resistant design. Solid rolled naval brass sheets were specified early in the plant's history. These sheets were generally satisfactorily corrosion resistant, but sometimes gave trouble on subsequent retubings due to stretching under the action of the tube expanders, and in a few cases, cracking in the ligaments between tube holes. Some steel sheets were made satisfactory for reuse by coating their water faces with bronze, applied as

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an overlay by brazing in the plant maintenance shops. This procedure was generally satisfactory, but in some cases where heat control was inaccurate excessive warpage occurred.

In 1947, it became practice to use steel tube sheets clad with ⅛-in. minimum-thickness naval rolled brass on the water side. This work is done by outside shops and involves silver brazing the brass to the steel. In many cases it is possible to salvage the steel sheets and apply the brass cladding to them after machining the corroded water faces. This type of construction has been used in bundles handling process streams at temperatures up to 570° F. With this high temperature, only occasional trouble due to loss of bond and separation between the steel base plate and brass cladding has developed.

As stated above, naval rolled brass has been generally satisfactory in its resistance to the plant's cooling water. A few cases of dezincification have been encountered. Usually this trouble has not been apperent until the tubes are removed from the bundle. In other instances local corrosion has occurred at gasket surfaces where corrosion of steel or cast-iron parts of the assembly has permitted high-velocity leakage. Use of a more expensive and more resistant brass for cladding, such as admiralty, has been considered advisable in only a few applications.

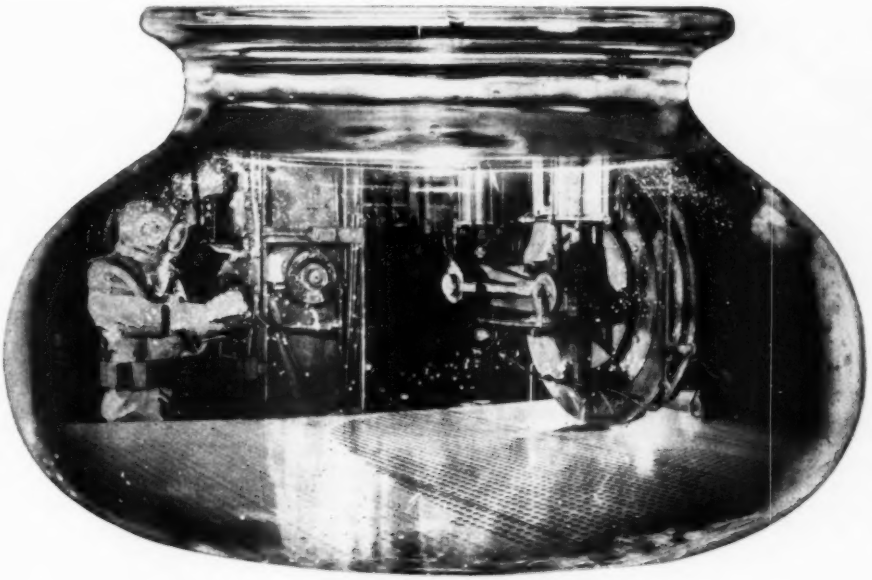
The few muntz-metal tube sheets installed on steam surface condensers have shown no dezincification or other attack. However, manganese bronze tube sheets, analyzed to be 39.1 per cent zinc, 58.6 per cent copper, 1 per cent iron, 1 per cent tin, and 0.3 per cent manganese, dezincified badly on the water side in 2 years of service on a bundle cooling lubricating oil for a turbogenerator.

Muntz metal used for tubes in a steam condenser failed badly in only 5 months of service due to layer-type dezincification. Comparison of this failure with the successful use of muntz metal tube sheets and consideration of the skin temperatures prevailing on the cooling water contacted surfaces in each application gives an indication of the temperature sensitivity of muntz metal to dezincification in brackish water. Performance of the muntz metal tubes was not surprising because this alloy is not recommended for brackish water service.

Life of inhibited admiralty tubes in this refinery has varied from less than 1 year in severe services to over 7 years in mild services. Almost all failures have been due to attack on the water side. Where service from admiralty has been poor, 70-30 cupro nickel with 0.5 per cent iron has been used, but this material has not proved superior in all cases.

Temperature Conditions

One important factor in the life of condenser tubes in the refinery is



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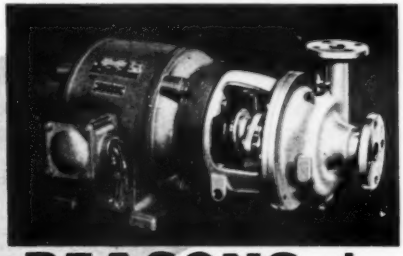

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temperature. Many of the condensers in the plant are arranged in banks consisting of two or three units stacked in series. Flow through these banks is countercurrent and results in maximum temperature of water and process stream in the top unit. In crude fractionator overhead condensing service, with hydrocarbon inlet temperatures from 250° to 300° F. and water outlet temperatures of approximately 125° F., the top bundle in a bank often gives less than 2 years of service; whereas the bottom bundles in the two-unit stacks have shown little tube damage in over 7 years of service. Furthermore, attack on a particular bundle is always most severe in the top section of a bundle where skin temperatures are highest.

In some cases the severe water side attack is confined to the section of the bundle near the hot vapor inlet. Attempts have been made to reduce this local attack by baffling to obtain more uniform distribution of vapors. However, in some cases little relief has been obtained by baffle charges and a freqquent result has been simply a shift in the area of attack.

Fig. 3 is a photograph of a flattened section of a tube which had given short life due to excessive wall temperature. It will be noted that attack is more severe in the top half of the tube than in the bottom half.

Velocity a Factor

Velocity has been found to be a critical factor in that high velocities have led to impingement attack and low velocities have caused concentration-cell corrosion. Velocity is closely related to temperature because for a given process side temperature the tube-skin temperature at the water contacted surface is dependent upon the amount, and hence the velocity, of water flowing through the tubes. Also, low velocities permit greater deposition of suspended solid materials from the water. These deposits are porous and nonprotective, but by virtue of their insulating effect cause an increase in tube-skin temperature.

The crude-fractionator overhead condenser tubes mentioned previously were found to fail by "concentration cell' corrosion, and water velocity through these tubes was therefore determined. It should be mentioned that water flow to condensing and cooling equipment is not measured but must be calculated on the basis of water-temperature increase and the amount of heat removed from the process stream, which is measured. The velocity in these tubes was found to be from 4 to 5 ft. per second.

In another service the hydrocarbon inlet temperature is in the neighborhood of 550° F. and admiralty tubes with water flowing at approximately 8 ft. per second last three times longer than in the 250° to 300° F. service even though the water outlet temperatures are approximately the same.

The slight amount of process side corrosion suffered by the tubes in crude-fractionator condenser service is not sufficient to account for the great difference in tube life, which must, therefore, be due to the effect of increased water velocity and consequent reduction of solids deposition and skin temperatures.

Indications are that impingement attack is not severe when velocity is below 8 ft. per second. However, such attack has occurred in bundles handling water at velocities considerably lower due to factors which create excessive turbulence, notably shallow water boxes and water-borne solid materials which partially block a tube bundle or individual tube. This attack is most frequently encountered near the inlet ends of tubes and attempts have been made to remedy it by the installation of ferrules to bear the brunt of the attack. In one such case aluminum-brass ferrules 9 in. long, carefully feathered at their outlet ends were installed in admiralty tubes. The leak frequency of the bundle and periodic inspection indicated that no benefits were derived from use of these ferrules. As additional experience was accumulated, it became evident that the ferrules were actually causing damage due to the unavoidable irregularity at their outlet ends.

Fig. 4 shows some aluminum-brass ferrules and the admiralty tubes in which they were located, after 30 months of service. The ferrule (A and B) has well protected the section of tube (C and D) which it covered; however, the right end of the tube sections shows severe impingement attack beyond the area covered by the ferrule. Similar, but more severe, damage was incurred by tube "F" in which the ferrule "E" was installed. Corrosion-erosion had reduced the wall thickness of tube "F" to almost zero in a band immediately downstream from the end of the ferrule. The possibility of galvanic action between the aluminium brass and admiralty was considered, but no evidence could be found to indicate that such action was an important factor in the local attack encountered.

Fig. 5 is a photograph of a 70-30 cupro nickel tube section showing impingement attack beyond a ferrule, which is nonmetallic. Figs. 6 and 7 give an indication of the superiority of aluminum brass and 70-30 cupro nickel over admiralty in resistance to impingement corrosion.

Fig. 6 shows a tube section in which a solid material has become enlodged and another section where such a solid appears to have lodged, but had become dislodged when the tube was removed from the bundle. Fig. 7 shows the same tube sections after cleaning. The grooving caused by excessive velocity and turbulence developed by tube obstructions is evident.

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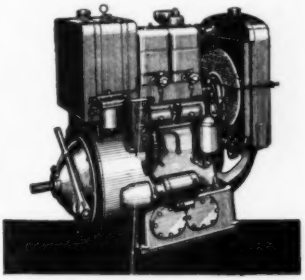

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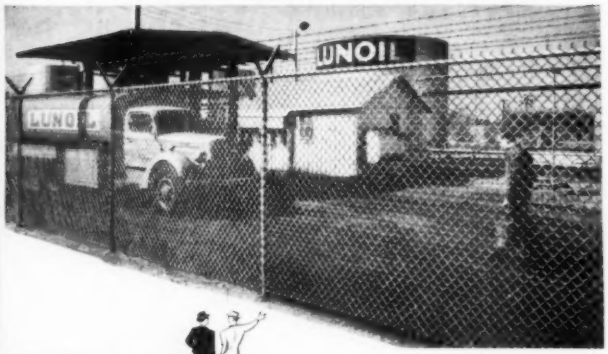

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Occasional cases of both "plug" and "layer type dezincification" are encountered in the refinery, under the same conditions which cause concentration-cell attack. Most of these cases have involved uninhibited materials, but a few cases involving inhibited materials are on record. Similar effects have been noted on 70-30 cupro nickel tubes, and Fig. 8 is a photograph of a section of "denickelified' cupro nickel tube. The free copper, which has been stained for photographic purposes, shows as the dark areas.

Tube Materials

As mentioned previously, 70-30 cupro nickel with 0.5 per cent iron has been used where the life of admiralty has been unsatisfactory. Approximately 4 years of experience with cupro nickel tubes has indicated that its prinicpal advantages corrosionwise are high resistance to impingement corrosion and stress corrosion cracking. It has not proved definitely superior where attack is of the concentration-cell type. It is, of course, inferior to admiralty in resistance to corrosion by the sulfur compounds in petroleum. However, in some high-sulfur services where impingement attack by the brackish water was causing frequent leaks in admiralty tubes, the high process side corrosion rate of cupro nickel is tolerated because its use greatly reduced the frequency of shutdowns necessary to plug leaking tubes and, thereby, effected savings in production and hydrocarbon loss.

Steel tubes are used for such services as ammonia and strong caustic which are highly corrosive to copper alloys. Fortunately, none of these services involve very high temperatures, and a life of from 1 to 2 years is realized from 14-gage steel tube bundles. However, the voluminous corrosion product formed by the action of brackish water on steel makes frequent cleaning of the tubes necessary to maintain reasonable heat-transfer rates.

Alclad 3S-H14 tubes of 0.065-in. wall thickness were tested and gave 30 months of service in a bundle serving to cool a 12 to 15 per cent water solution of diethanolamine from 160° to 135° F. before perforations from the diethanolamine side made retubing necessary. These tubes were rolled into steel tube sheets and showd severe galvanic attack at the tube ends after 30 days of service. Installation of zinc plates on the tube sheets and in the channel of this cooler greatly reduced, but did not completely stop galvanic attack. Appearance of the water side of one of these tubes, selected at random, beyond the area of local galvanic attack which extended 3 in. into the tubes, is shown in Fig. 9. It will be noted that the pits formed were shallow, indicating that the cladding had cathodically protected the base metal as intended.

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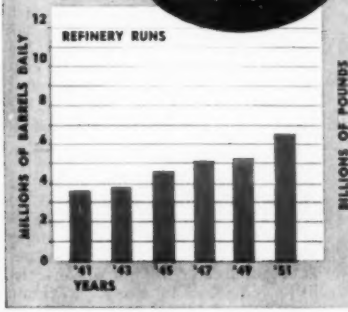

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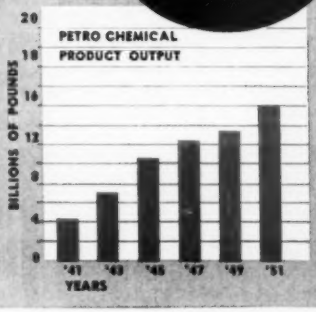
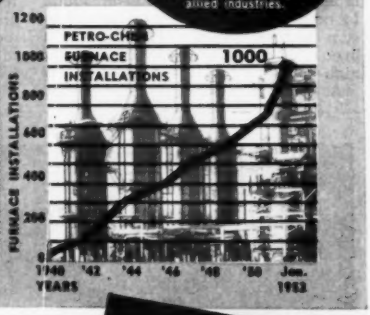


In 1940 there was 1 In 1946 there were 400 and as of Feb 1952 there are more than 1000 Petro-Chem Iso-Flow Furnaces performing in the petroleum, chemical and allied industries.



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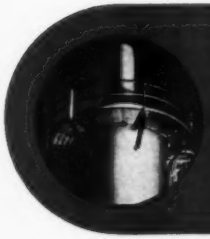

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When this bundle was retubed with Alclad 3S-H14 tubes, the tube sheets were metalized with zinc to provide a better distribution of anodic material and, thereby, effect more complete cathodic protection of the tube ends than was obtained by the use of zinc plates.

Heads and Covers

The ferrous channels, channel covers, and floating head covers installed in the refinery have undergone extensive corrosion damage. Use of brass and brass-clad tube sheets has increased the rate of corrosion of these parts. As with steel tube sheets, the gasket surfaces of these parts have required special attention and for a number of years the plant practice has been to rebuild gasket surfaces of cast iron parts with bronze and those of steel parts with monel or nickel.

Partitions in channels and floating head covers, being subject to attack on two surfaces, have often required replacement with naval brass. These repairs have made it possible to keep most of the original equipment, which is now over 7 years old, in service. Monel-lined parts have been found to be very highly resistant to corrosion in this service, but have not been used extensively because of their high cost.

A test installation of magnesium anodes was made in the water boxes of a surface condenser in an effort to reduce severe galvanic attack on the steel boxes which results from coupling the steel with muntz-metal tube sheets. This attack is especially severe near the junction of the two metals and is typical of that encountered throughout the plant where similar couples exist in heat-exchange equipment. One 8-in.-long by 8-in.-diameter magnesium anode weighing 25 lb. was installed on each of the four inspection plates in the cover plates of each water box, so that 100 lb. of magnesium was present in each water box.

Both water boxes are 6 ft. in diameter; the inlet and outlet box is 27 in. long, and the return box is 18 in. long. The anodes were mounted by inserting studs through their integrally cast ¾-in. steel pipe cores and were electrically insulated so that they could be controlled externally by insertion of resistance wire without interfering with the operation of the condenser. The exterior portions of the assembly were enclosed in explosionproof fittings.

When first connected with no intentional external resistance, the anodes were each developing slightly more than 4 amp. At this current output, the anodes would have been expended in about 4 months, but adjustment to an output of 0.5 amp. per anode was made by insertion of a 20-in. length of Chromel No. 20 wire in the external circuit of each anode. This adjustment resulted in a current density of 23.7 ma. per square foot in the smaller box and 17.9 in the larger box.

Inspection of this condenser 7 months after the anodes were installed showed that very little, if any, protection had been provided by the magnesium anodes and they were, therefore, readjusted to provide 30 ma. per square foot in one box and 38 in the other. Another inspection 2 months after this adjustment showed protection in small areas around the anodes, but one anode had completely disappeared and another had been hollowed out such that it would soon have became disengaged from its steel pipe core.

The anodes were unable apparently to polarize the steel surfaces at the current densities used, probably because of the dissolved oxygen, chlorine, and turbulence present. The conclusion reached as a result of this test was that excessive amounts of magnesium would be required to protect bare steel water boxes. However, the tests are to be continued in conjunction with coatings, which will reduce the steel areas requiring protection to those left exposed by coating holidays and effect a great reduction in the large cathodic area presented by the muntz-metal tube sheets.

Hot-Water Lines

Steel pipe used in hot water discharge lines from condensers has given highly unsatisfactory service; in some cases, leaks have developed in 1 year. Schedule 80 pipe was used to obtain greater life but this effected little reduction in excessive annual costs for hot-water piping. Early in 1951 lines from one group of condensers were replaced with baked phenolic plastic-coated steel lines. A trepanned specimen was removed from a section, in which prior experience had indicated a high corrosion rate, after 6 months of service and no deterioration of the coating or attack on the steel was noted. The good condition of this specimen and the absence of leakage after about a year of service has led to extensive use of similarly coated lines for hot-water service. Plastic coating adds about 30 per cent to the fabricated cost of Schedule 40 piping with Series 15 fittings. Part of this increase is offset by the use of Schedule 40 instead of Schedule 80 pipe and it is conservatively estimated that the life of the coated lines will be more than twice that of bare steel lines.

Acknowledgment

Grateful acknowledgement is made to the engineering inspection and laboratory departments of Cities Service Refining Corp. for their assistance in the preparation of this article.

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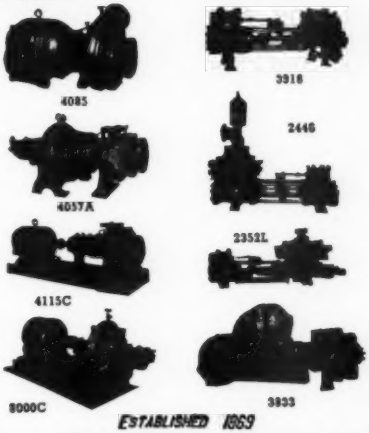

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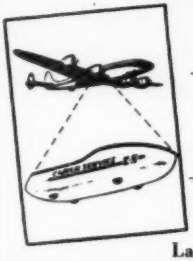

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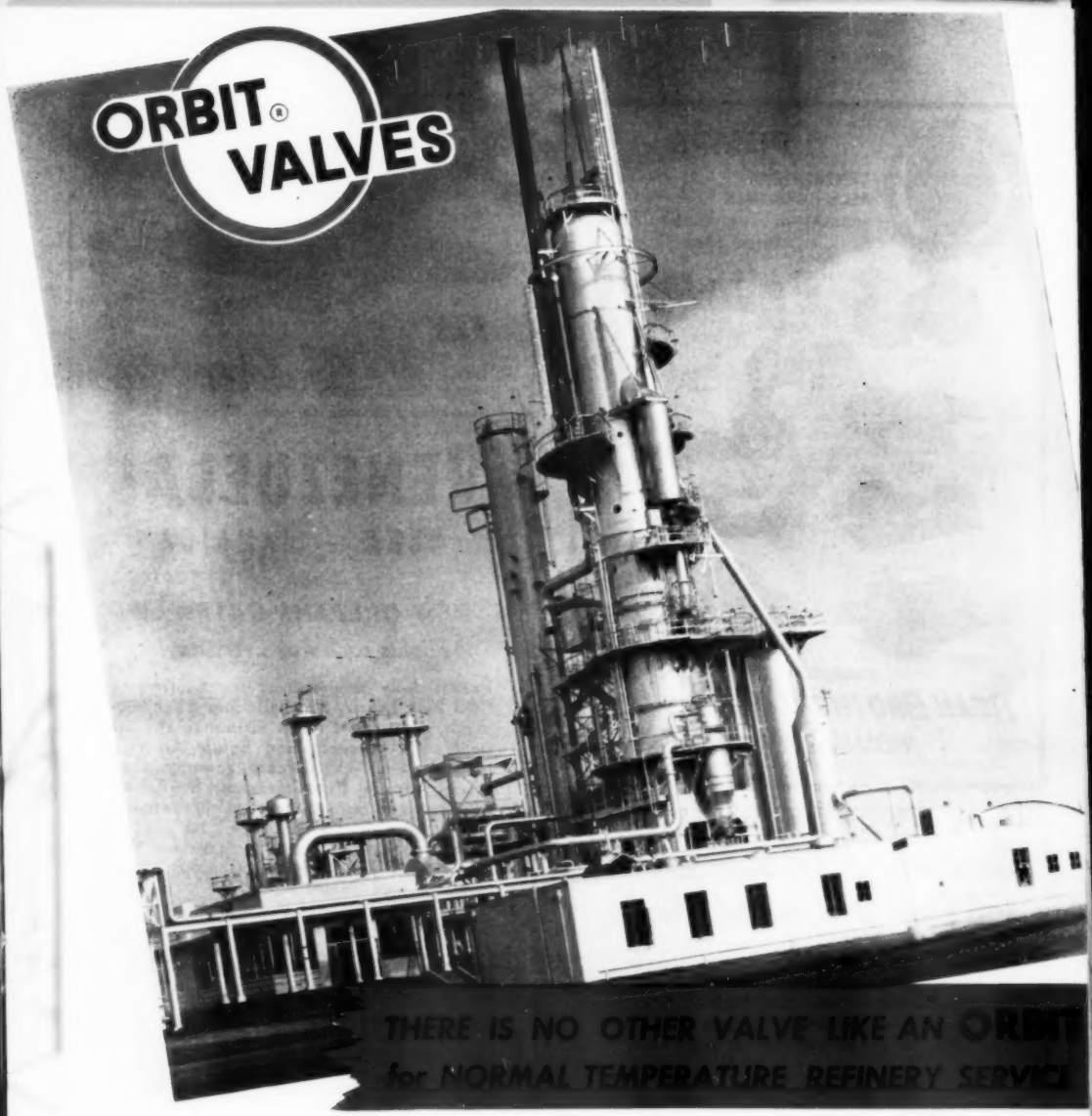

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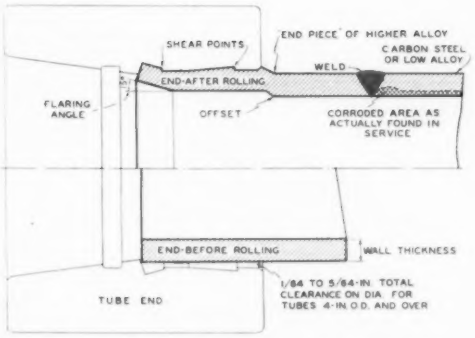


Fig. 1—Joint with plain and "safe-ended" tube.

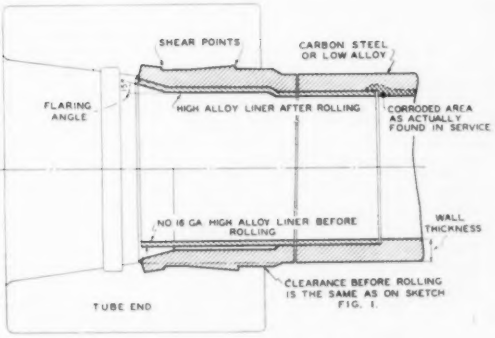

SHEAR POINTS
CARBON STEEL OR LOW ALLOY
FLARING ANGLE
HIGH ALLOY LINER AFTER ROLLING
CORRODED AREA AS ACTUALLY FOUND IN SERVICE
NO 16 GA. HIGH ALLOY LINER BEFORE ROLLING
WALL THICKNESS
CLEARANCE BEFORE ROLLING IS THE SAME AS ON SKETCH FIG. 1.
TUBE END

Fig. 2—Joint with high-alloy end liner.

How Gulf Oil Corp. reduces

FURNACE TUBE-END CORROSION

by F. C. Braun*

Records show inside-outside upset furnace tubes when accurately machined and properly expanded decrease tube-end corrosion

THE localized corrosion occurring at furnace-tube ends represents a serious and continuing problem for refiners. This type of corrosion has for many years been successfully minimized by Gulf Oil Corp., employing a method for rolling in close-tolerance-machined, upset tubes. The advantages of this practice are evidenced by extensive and detailed case histories which are kept on all furnace tubes installed in the company's eight domestic refineries.

*General engineering department, Gulf Oil Corp., Pittsburgh.

The development of thermal cracking processes, involving higher oil temperatures and pressures, coupled with increasing corrosivity of crudes and charging stocks, tended to aggravate the problem of maintaining a satisfactory economic balance among stream time, down time, maintenance costs, and safety.

Thorough inspections of units, recording and establishing corrosion rates, served as a guide in taking measures to prolong the life of equipment and to add to the safety of the units.

One of the items that gave great concern was corrosion of still tubes, which was particularly apparent where charging stock was heated to a temperature above 600° F. From the calibration records which are kept for each and every still tube, it was found that, at approximately this temperature, corrosion begins to accelerate but, depending on the nature of the charging stock, tends to level off at approximately 900° F.

Gulf had been using 5 per cent chromium tubes in West Texas crude and charging-stock service, but later proc-

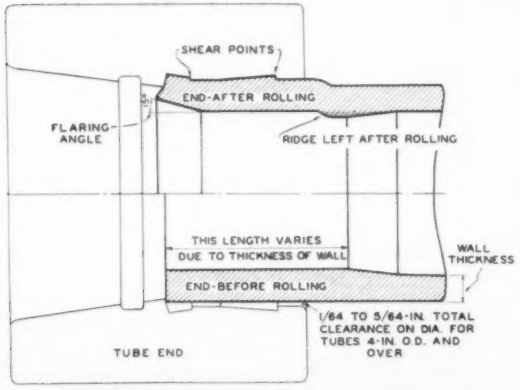

SHEAR POINTS
END-AFTER ROLLING
FLARING ANGLE
RIDGE LEFT AFTER ROLLING
THIS LENGTH VARIES DUE TO THICKNESS OF WALL
WALL THICKNESS
END-BEFORE ROLLING
1/64 TO 5/64-IN. TOTAL CLEARANCE ON DIA. FOR TUBES 4-IN. O.D. AND OVER
TUBE END

Fig. 3—Joint with unmachined inside-upset tube.

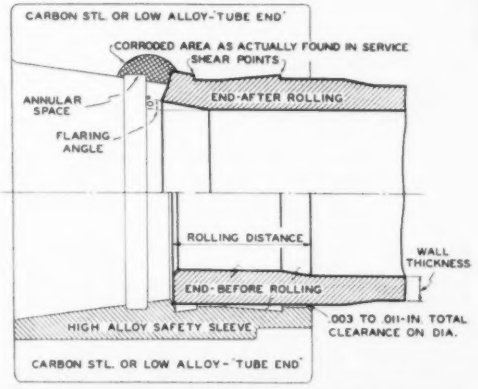


Fig. 4—Machined, inside-outside upset-end tube.

ess developments involving more severe operating conditions demanded the use of higher chromium alloys such as 7 and 9 per cent chromium molybdenum. These materials helped to overcome corrosion difficulties in the critical sections of the heaters. However, a study of calibration reports showed that corrosion rates varied greatly throughout tube lengths. While the maximum rate was apt to occur anywhere in the tube, it was found most frequently at the inlet end in the rolled (expanded) section.

Not infrequently, tubes had to be removed after only half the service life which would have been obtained had end corrosion been no more severe than that through the tube lengths away from the rolled sections.

It was recognized that the excessive deterioration in the rolled ends of tubes was related to stresses set up during expansion, distortion of metal structure, and erosion caused by turbulence at the internal offset formed by the expander during the roll-in operation. It was further recognized that the greater amount of expansion the greater would be each of the above factors, and the greater would be the resultant corrosion.

Since the amount of expansion required for a satisfactory joint is to a great extent dependent on the outside diameter of tube, inside diameter of tube hole in header, and tube-wall thickness, all subject to wide tolerance variations, the amount of expansion will vary accordingly, and therefore may be excessive, in which case corrosion rate will be increased. Because of these variations in corrosion rates in the roll, tube life has varied considerably from one tube to another.

Remedial Methods

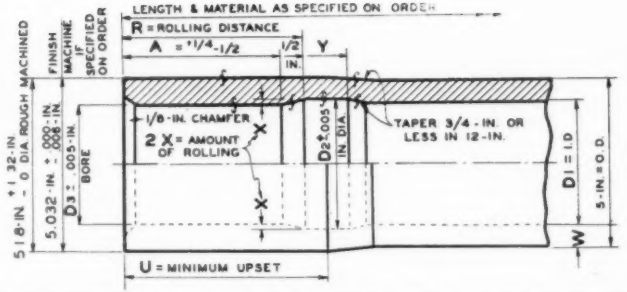
The relatively high incidence of tubes lost through end corrosion, only, during the early days of thermal cracking led to trials of several remedial methods by Gulf, such as safe ending; high-alloy end liners; inside-upset tube ends; and, finally, present standards for inside and outside-upset ends machined to close tolerances. Each of these methods will be described and discussed briefly.

Safe ending.—This consists of welding end pieces (not upset) of a higher alloy to the basic tubes. This method has proved to be successful in reducing end corrosion; however, accelerated corrosion of the basic material was experienced in many instances at the welded joint (see Fig. 1). This higher rate of corrosion must be attributed to the effect caused by the different corrosion rates of the two materials and the resulting turbulence at the joint.

In safe ending of carbon steel tubes, the economics must be considered as ends of alloy steel require alloy headers or sleeves of higher hardness to insure good shear points, after the rolling operation, as illustrated in Fig. 4. Another practical disadvantage lies in the fact that it is inconvenient to inspect the welds.

Liners.—As to alloy liners, ends of tubes are bored to accommodate a liner of high alloy, approximately 18 in. long, No. 12 gage metal thickness, of the same inside dimension as the tube. The tube is expanded without the liner, after which the liner is inserted and expanded over its entire length into the bored section of the tube. Fig. 2 illustrates this type of installation.

The liners increased the tube life, but the method was not dependable. Excessive corsion sometimes occurred at the inside end of the lin-


LENGTH & MATERIAL AS SPECIFIED ON ORDER
R = ROLLING DISTANCE
A = 1 1/4 - 1/2
1/32 IN.
Y
FINISH MACHINE IF SPECIFIED ON ORDER
MACHINED
5.032 - IN + .000 - .008 - IN
5.18 - IN +1.32 - IN - 0 DIA ROUGH
D3 = .005 - IN BORE
1/8 - IN. CHAMFER
2 X = AMOUNT OF ROLLING
D2 +.005 - .000 IN. DIA
TAPER 3/4 - IN. OR LESS IN 12 - IN.
D1 = I.D
5 - IN = O.D.
W
U = MINIMUM UPSET

MARK	D_1 I.D	D_2 +.005 -.000	D_3 +.005 -.000	R	A +1/32 -1/64	U	2X	W	Y	REMARKS
5P1	4¼"	4.250"	4.141"	2½"	2"	3"	SEE SKETCH NO.6 FOR PROPER AMOUNT OF ROLLING FOR ALL TUBES	3/8"	1½"	
5P2	4¼"	4.250"	4.141"	3"	2½"	3½"		3/8"	1"	
5P3	4¼"	4.250"	4.141"	4"	3½	4½"		3/8"	1"	
5P4	4⅛"	4.125"	3.984"	2½"	2"	3		7/16"	1½"	
5P5	4⅛"	4.125"	3.984"	3"	2½"	3½"		7/16"	1"	
5P6	4⅛"	4.125"	3.984"	4"	3½"	4½"		7/16"	1"	
5P7	4"	4.000"	3.844"	2½"	2"	3"		½"	1½"	
5P8	4"	4.000"	3.844"	3"	2½"	3½"		½"	1"	
5P9	4"	4.000"	3.844"	4"	3½"	4½"		½"	1"	
5P10	3⅞"	3.875"	3.703"	2½"	2"	3"		9/16"	1½"	
5P11	3⅞"	3.875"	3.703"	3"	2½"	3½"		9/16"	1"	
5P12	3⅞"	3.875"	3.703"	4"	3½"	4½"		9/16"	1"	
5P13	3¾"	3.750"	3.547"	2½"	2"	3"		5/8"	1½"	
5P14	3¾"	3.750"	3.547"	3"	2½"	3½"		5/8"	1"	
5P15	3¾"	3.750"	3.547"	4"	3½"	4½"		5/8"	1"	

NOTES:-

MATERIAL & LENGTH OF TUBES TO BE AS SPECIFIED ON ORDER
BOTH ENDS TO BE UPSET AS SHOWN UNLESS OTHERWISE SPECIFIED ON ORDER
ALL FINISHED SURFACES TO BE MACHINED CONCENTRIC WITH INSIDE DIAMETER OF TUBE
FINISHED SURFACES TO BE PAINTED WITH A HEAVY GREASE PROTECTING COAT
OUTER MACHINED SURFACES TO BE SUFFICIENTLY PROTECTED FOR SHIPMENT

Fig. 5—Tube-end machining specifications.

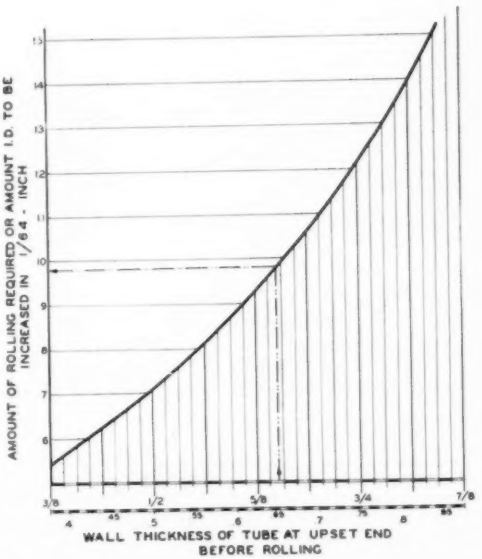


Fig. 6—Rolling specifications for inside-outside upset tubes. Example: Wall thickness at upset = 21/32 in. Amount of rolling = 10/64 in. (Scale for wall thickness graduated in 64th inches.)

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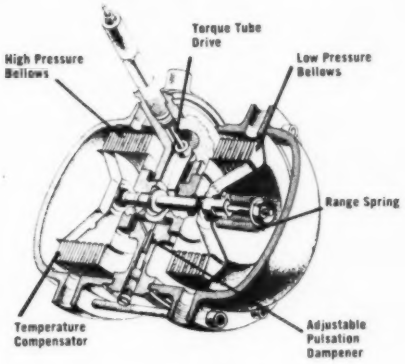

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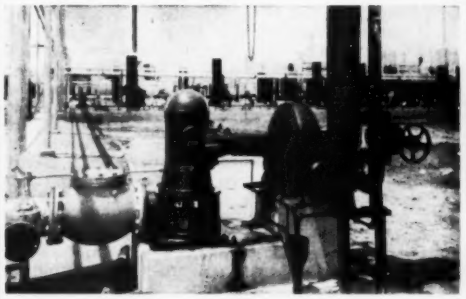

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er, the extent of which was difficult to determine on inspection. This is illustrated in Fig. 2. In some instances where liners apparently become loose due to operating conditions, it was found that coke had been deposited behind liners, causing them to bulge. Due to these disadvantages, the use of tube-end liners was not considered to be a satisfactory method for corrosion protection of tube ends.

Internal upset.—In an effort to provide a smooth inside surface after rolling, free of an offset, such as that illustrated in Fig. 1, and free of turbulence and erosion which naturally results from such an offset, attention was directed toward tubes with ends upset on the inside. In theory, this would give sufficient metal to provide for corrosion, and to produce a rolled internal surface free of an offset. Fig. 3 illustrates this type of tube end. This method was a step in the right direction, but was not entirely satisfactory because of the variations in lengths of inside upsets as produced in the mill operation.

It was found that this length variation often resulted in an inside ridge left after rolling, as illustrated in Fig. 3. Removal of this ridge by grinding was costly. Another disadvantage in the use of inside upset tubes lay in the rough outside surface which resulted from the upsetting operation. Considerable grinding of this surface was necessary to make a satisfactory joint.

Upsetting and machining. — It was recognized that machining the inside upset to established dimensions, and upsetting and machining the outside surface, all of which could be done in parallel operations, would overcome the difficulties experienced with the standard mill inside upset tubes not machined, as well as difficulties experienced with other methods. Since machining was in order, advantages in machining to close tolerances could be foreseen.

It was evident that a close tolerance between diameters of heater and tube would reduce the amount of preroll expansion. In addition, the uniform wall as a result of machining outside and inside diameters in one operation reduces the amount of final expansion and makes this expansion uniform. The resulting lesser amount of expansion would consequently reduce cold working, flaking, and deforming of metal structure, all of which would serve to reduce tube-end corrosion. It was rightfully assumed that the advantages gained by this method should more than offset the cost of upsetting and machining to close tolerances.

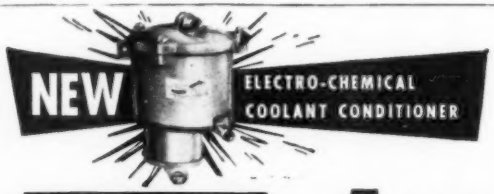
An investigation[1] was made to secure necessary information for establishing definite specifications for the upsetting and machining of various combinations of tube diameter, wall thickness, and material.

It was interesting to find that, with ends machined to close tolerance (Fig. 5), carbon steel and chromium-molybdenum alloys up to 9 per cent chromium, 1 per cent molybdenum could be given the same amount of rolling.

The investigation also revealed the importance of the flaring angle on the rolling tool. It was observed that the wide-angle flaring rolls will cause a longitudinal flow of the tube material, injuring the shear points formed by the straight expander rolls. Rolling tool with 20° included flaring angle was found most desirable. (See Fig. 4.) These data then permitted the development of a single curve of rolling dimensions as illustrated in Fig. 6.

Data derived from the investigation revealed that advantages to be gained, from a rolling standpoint, were many. An illustration to demonstrate these advantages can best be presented by means of an example using a standard plain-end still tube. Such tubes as received from the mill may vary as much as 1/16 in. on the outside diameter, with a permissible wall thickness variation of minus 0 per cent to plus 28 per cent. With this wall-thickness tolerance, the wall of a ⅝-in. minimum wall tube may vary from 0.625 to 0.800 in.

Degree of rolling.—Since wide tolerances always result in variations in expansion from tube to tube, each connection has to be treated as a special case. Because of the fact that the amount of expansion is a function of tube-wall thickness, on an eccentric wall tube the heavy wall must



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govern in establishing the required amount of expansion to obtain a satisfactory joint. Because of this, the thinner wall section of the tube is over-expanded, which results in overstressing, thus introducing an opportunity for an increased corrosion rate and, consequently, a shorter life for the tube end.

The amount of expansion also is influenced by the variation between diameters of tube and tube hole, varying from 1/64 to 5/64 in. Tubes usually have scale and surface imperfections which must be removed, further increasing the diameter variations. These conditions influence greatly the time required for making satisfactory joints. Often, two tools are required due to the large amount of expansion necessary. As a result of scale and imperfections on inside of tube, the life of rollers is reduced.

The adoption of machining specifications for tube ends (Fig. 5) eliminates disadvantages. Due to the close tolerances, the amount of expansion, and resulting stressing, are reduced to a minimum. No offset remains after the rolling operation since the upset close-tolerance-machined inside diameter provides for the metal displaced by the rolling operation, and finishes off the rolled inside diameter at the nominal inside diameter of the tube. These two features account for the elimination of excessive tube-end corrosion, resulting in a fairly uniform corrosion rate throughout the entire tube length, with a correspondingly longer tube life.

Additional advantages are achieved in line of safety and economics. It must be agreed that machined surfaces will produce tighter joints, particularly with closely controlled expansion. Coke buildup in rolled section between tube and header is less likely to occur with this method, which reduces considerably the danger of header blowoffs.

Due to the machined surfaces, no time has to be spent in cleaning ends prior to the assembling for rolling. The inside machined surface of the upset tube end extends considerably the life of the rolling tool. The lesser rolling time required due to the close tolerances, and to the possibility of completing the rolling with one tool, results in considerable savings.

All of these points contribute to the economic advantage of this method. This is true even in regard to retubing into old headers with tube holes moderately enlarged by earlier rollings, because, for such cases, new tubes are ordered rough-machined only, on outside surface, which permits the refinery to dress the outside, as required, to fit satisfactorily into the old headers. Where header holes are considerably enlarged and/or show excessive corrosion in the annular space, Gulf practice is to install safety sleeves as illustrated in Fig. 4.

Gulf maintains a record on each still tube,[2] which includes material, date of installation, and calibrations at roll and away from roll, at both ends. Calibrations are taken at established intervals, and recorded. The progressive calibrations permit the determination of corrosion rates, which in turn permits remaining life to be estimated, and changes in tube material to be recommended, if changes appear to be economically desirable.

Close-tolerance machining specifications have proved their worth, in view of the history to date which shows decreased tube-end corrosion, increased tube life, deceased demands on time and maintenance, and a good safety record, all of which point to the attainment of sound and uniform tube-to-header connections.

It should be noted that the close-tolerance-machining specifications are applied only in the case of furnaces which operate under severe operating conditions. As a part of the economic approach, furnaces which operate under relatively mild service and corrosion conditions are equipped with mill production standard tubes.

References

1. Refiner and Natural Gasoline Manufacturer, July 1940.

2. "Corrosion Rates of 10,000 Still Tubes Guide Selection of Steels"—National Petroleum News, October 20, 1937.

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Fig. 1—Mixing and storage tank and pumps for injecting corrosion inhibitor to crude still condenser systems.

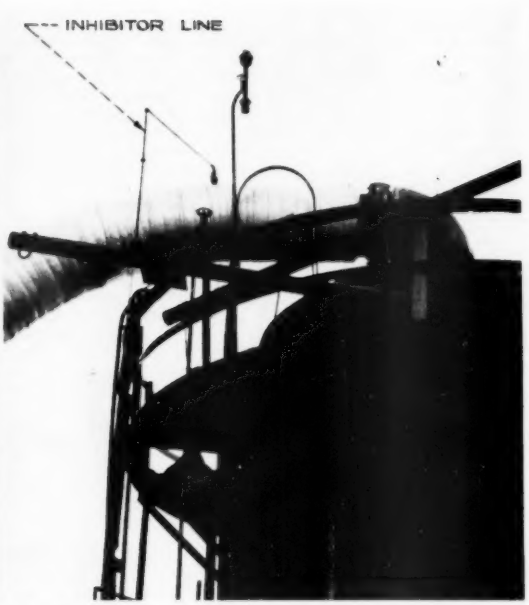

Fig. 2—Inhibitor is fed into overhead lines of atmospheric tower and also to debutanizer, via separate lines.

How to Control Internal Corrosion of Crude Still Condensers

by Marion J. Wilcox* and Franklin M. Watkins†

Use of inhibitors has strengthened the weakest link in this refinery chain, so that shutdowns for general overhaul can now be scheduled

IN recent years many troublesome corrosion problems have been helped or controlled by using organic inhibitors. For example, interior surfaces of distillate-fuel-handling equipment, including pipe lines, pumps, meters, carburetors, tanks, etc., are now being protected by product-soluble organic inhibitors. In some instances this type of corrosion is exceedingly severe. Distillate-fuel product tankers are being protected from corrosion that once cost more than $20,000 per year per tanker. One product-soluble inhibitor eliminates more than 95 per cent of this cost. Corrosion in circulating water-cooling systems is also being controlled, as it is in producing wells and in waterflood systems. Organic inhibitors now are also helping to protect refinery distillation equipment.

*Technical director, Sinclair Refining Co.'s Hartford, Ill., refinery, and †director, Sinclair Refining Co.'s corrosion engineering division.

Corrosion results from reaction between water and metal. The metal is either removed or converted to products which do not have the strength and lasting properties of the original metal. The rate of corrosion is controlled by impurities, which are present in all crudes in varying amounts, and is progressively more rapid at higher temperatures. Agents which accelerate the rate of corrosion, and the mechanism of their action, have been dealt with at length in many previous articles. It is sufficient here to remember that the rate is accelerated by oxygen, carbon dioxide, hydrogen sulfide, and hydrochloric acid, which are present with water in varying proportions in the condensate from distillation of crude oil.

Preventing corrosion.—Many methods have been successfully used to control the corrosion rate, but all have not been completely satisfactory to date in some applications. Corrosion-resistant alloys have materially increased the life of distillation equipment. Control of pH by neutralizing acids and acidic water to a pH of 7 to 9 with ammonia or other alkalies has also been of material assistance. In extreme cases, storage and accumulator tanks have been lined with gunite, a layer of cement, which is very effective in lengthening equipment life. Nonetheless, corrosion in many cases continued at an unfortunately high rate until inhibitors were applied.

Condenser systems.—Sinclair Refining Co.'s crude-still condenser systems at Hartford, Ill., are well equipped with corrosion-resistant alloys and liners. Overhead and header pipes of the atmospheric tower section and debutanizer section of the crude still are for the most part carbon steel. Heat exchangers are monel lined, and the bundles are assembled

with admiralty tubes. Admiralty tubes are also used in the submerged condensers. Accumulator tanks are gunite lined. This system operates about 25 days per month on Mid-Continent crude containing 0.6 per cent sulfur and 5 days per month on Wyoming crude containing 2.0 per cent sulfur. The goal for this still once was a scheduled 90 to 100-day run, but quite frequently major leaks in heat exchangers, condensers, or pipe lines caused unscheduled shutdowns short of the 90 to 100-day plan.

In spite of all attempts to control corrosion, this continued to be a constant source of trouble as indicated by the frequency of exchanger-tube bundle replacement shown in Table 1. Individual bundles, of which we have an exact record since December 12, 1948, have lasted as long as 476 calendar days, but the average life of the six bundles for which a record is available is only 274 days. Bundles were changed at intervals of 210, 98, 168, 44, 30, 136, and 66 days, total elapsed time.

TABLE 1—TOTAL EXCHANGER-TUBE BUNDLE LIFE BEFORE USE OF A CORROSION INHIBITOR

Position number—	Life (days)
Crude debutanizer system:	
121 bottom	136
121 bottom	66
Atmospheric tower system:	
45 top	444
45 middle	210
45 middle	310
45 bottom	476
Average life	274

Inhibitor.—For condenser systems we are now using at Hartford a low-viscosity inhibitor, which is soluble in the overhead product from the crude still. This experimental corrosion inhibitor, developed by Sinclair, adsorbs on iron and iron oxides as a monomolecular film. It also films other metals, providing a very thin layer separating the metal surfaces from corrosive solutions and thereby preventing contact and chemical action between the metal and these solutions. It has little or no tendency to build up a coating which would interfere with heat-transfer rates or with passage of gases through small-diameter pipes or through narrow channels in exchanger bundles.

This inhibitor is being used as a kerosine blend containing an equal volume of inhibitor and kerosine. The blend is prepared and stored in the small tank shown in Fig. 1. Pumps shown in this figure transfer the inhibitor blend through individual ¼-in. lines from the storage tanks into the distillate lines from the atmospheric tower (see Fig. 2) and from the crude debutanizer at a rate of 4 gal. per hour. These pumps are allowed to run for 30 minutes a day and during this time deliver 1 gal. of inhibitor and 1 gal. of kerosine to each line.

Dosage.—One gallon of inhibitor in 24 hours is adequate in a system which has been saturated with inhibitor. This dosage is so small that

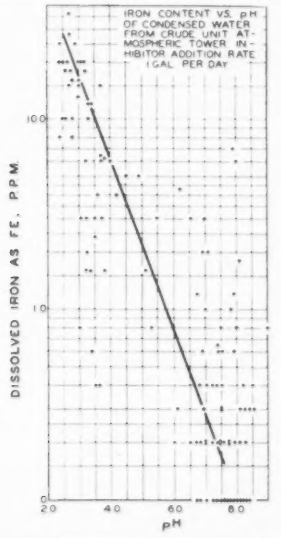

Fig. 3—Iron content vs. pH of condensed water from crude unit atmospheric tower. Inhibitor addition rate 1 gal. per day.

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it has no appreciable effect on the products of the still. It is used on one system producing 3,500 bbl. a day of distillate and 2 g.p.m. of water; and in another system, the atmospheric tower, producing 4,000 bbl. of distillate per day and 5 g.p.m. of water. Inhibitor added during a 30-minute period is enough to coat the entire system, refilming areas from which inhibitor has been lost during the preceding 23½ hours.

Within 30 minutes after the inhibitor is started into the system its effect is apparent in the water withdrawn from the system. It gradually becomes milky, and has a soapy feel. A 4-oz. bottle of this water settles within approximately 30 minutes to about 90 per cent of its original volume; thereupon, particles of corrosion products washed from the system are apparent on the bottom and suspended throughout the otherwise clear water. A small amount of organic matter, about 0.1 to 0.25 per cent of the total volume, floats to the top. The water drawoff remains milky for about 3 hours after the inhibitor addition is started, and thereafter becomes clear. Before an inhibitor was used in this system, the water ran black with suspended corrosion products at all times.

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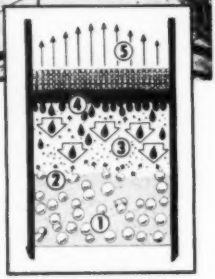

HOW IT WORKS

(1) Gas passes through liquid. (2) Bursting gas bubbles produce fine spray of liquid droplets. (3) Droplets are entrained in rising stream. (4) Droplets coalesce on knitted-wire surfaces to form large drops that fall back against the flow. (5) Gas passes on, freed from entrainment. The liquid is returned.

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THE AUTHORS

M. J. WILCOX

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Marion J. Wilcox is technical director of the Hartford, Ill., refinery of Sinclair Refining Co. He received a B.S. degree in chemical engineering from Michigan State College in June 1939. He spent 8 months with General Chemical Co. as control chemist before joining the research and development department of Sinclair Refining Co. at East Chicago, Ind. During World War II, he prepared studies of various Sinclair refineries evaluating various cracking and processing schemes for wartime production of aviation gasoline and rubber-plant feed stocks. Following the war he aided in building and the operation of a fluid pilot plant so that correlations helpful to refineries in the operation of their new catalytic processes could be made. He was advanced to his present post on January 1, 1951.

Franklin M. Watkins, of Sinclair Research Laboratories, Inc., at Harvey, Ill., received a B.S. degree in chemical engineering and a M.S. degree in chemistry from University of Colorado. As a test engineer in General Electric Co.'s research laboratories he became interested in the chemical and physical properties of transformer oils and as a result, was employed by Sinclair Refining Co.'s research department in 1936. With Sinclair, he directed additive synthesis, and formulation of petroleum products with these additives, and in 1948 become director of the corrosion engineering division.

Sampling. — Inhibitor addition is usually started at 2:00 p.m. On an average day water samples are taken four times—at 8:00 a.m., 10:00 a.m., 12:00 noon, and 2:00 p.m., just before inhibitor is added. Samples are taken at these periods in order to show any tendency for corrosion to commence, as progressively more of the inhibitor film is washed from metal surfaces. Evidence to date indicates that there is still substantially no corrosion taking place at 2:00 p.m. in spite of the fact that inhibitor was batched into the still 23½ hours earlier.

Inhibitor efficiency is evident from data shown in Table 2 in which is shown effect on life of five bundles after use of corrosion inhibitor. These

TABLE 2—EXCHANGER-TUBE BUNDLE LIFE AFTER USE OF A CORROSION INHIBITOR
(Number of days in service)

Position No.—	Before inhibitor	After inhibitor	Total to failure
Crude debutanizer system:			
121 top	277	262	Above 539
121 bottom	75	262	337
Atmospheric tower system:			
45 top	75	262	Above 337
45 middle	307	262	Above 569
45 bottom	351	262	Above 613
Average life			Above 479

five bundles had been used for 75 to 351 calendar days before inhibitor was added to the system and have been used 262 days since inhibitor was introduced. Of this group, one bundle has failed. That bundle from the bottom section of exchanger No. 121 had been in service 75 days and from Table 1 it is apparent that this is near the maximum life which could have been expected from a bundle in this position. Nevertheless, it continued to operate for 262 days, and the other bundles are still operating satisfactorily.

Analyzing Results

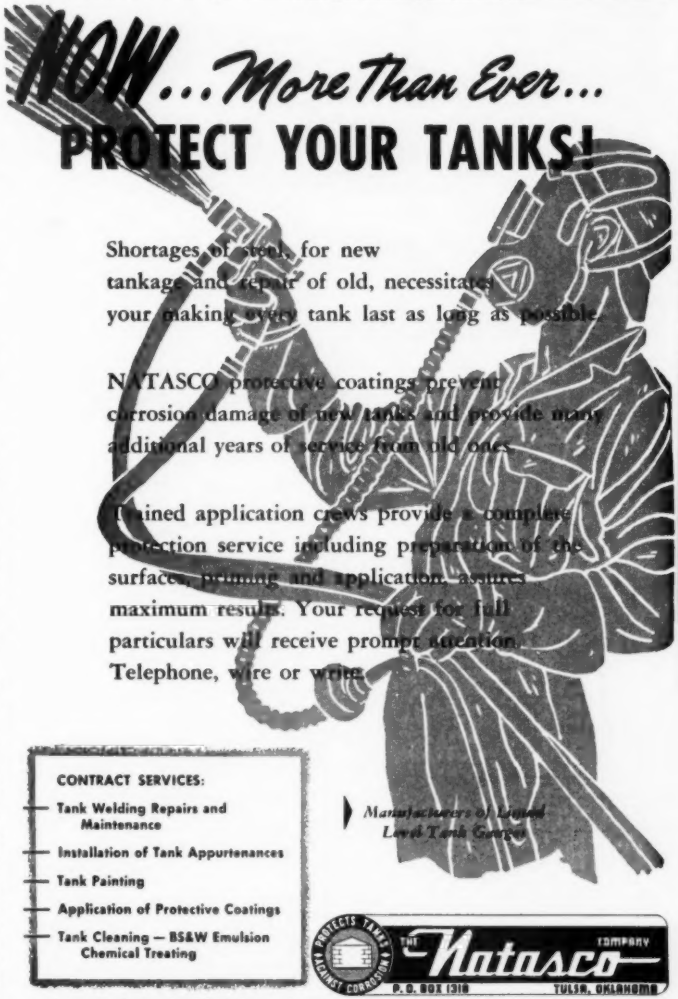
Initial encouraging results led to the hope that the use of ammonia could be discontinued. Occasionally the flow of ammonia has been interrupted by some operating or mechanical difficulty. The iron content of the discharge water rises rapidly as the protective film is washed away by water whose pH has been allowed to drop below 5.0. Fig. 3 shows a large number of test results plotted on semilogarithmic paper. Analytical results of zero iron content are shown on this plot in the position of 0.1 p.p.m. iron. An exact correlation is not possible since time is required to wash away the protective film, but it is apparent that use of ammonia must be continued to maintain a pH of 5 to 8, in order to assure a low corrosion rate.

Initial dose.—When inhibitor is first added to an old system it is advisable to use large initial doses. For the first week we used 5 gal. a day in each system to put the initial protective film over all metal surfaces, and for the second week a daily dosage of 3 gal. was used. The inhibitor when first added to a dirty system tends to suspend corrosion products to carry them along with the distillate steam, thus cleaning up the condenser system. The amount of corrosion products carried out of the Hartford system was so great at first that on several occasions water withdrawal lines were temporarily plugged and were released by back pressure from a steam line.

Iron content.—A quick appraisal of the efficiency of inhibitor dosage can be obtained by analyzing the effluent water. Analysis of filtered water samples is sufficiently rapid and accurate to evaluate the minimum required inhibitor dosage or the efficiency of individual inhibitors. Before inhibitors were used at Hartford, analysis of several water samples averaged 34 p.p.m. iron in the atmospheric water tower and 37 p.p.m. in the crude debutanizer water, with individual analytical figures showing results as high as 72 p.p.m. iron. Samples taken while the pH was in the range of about 5 to 8 during the period between October 1 and November 15, 1951, averaged 1.6 p.p.m. iron, in the atmospheric tower water, and 1.2 p.p.m. in debutanizer water. The same water samples averaged 0.2 to 0.3 p.p.m. copper and zinc, indicating that the corrosion rate on the copper and zinc alloys is now negligible.

Aid corrosion control.—It is improbable that inhibitors will be effective enough to allow operation without alloys under severely corrosive conditions. They must be considered as aids to control corrosion rather than as "cure-alls." They will aid in conservation of scarce or expensive alloys. Until more information is available, it must be assumed that sour crude cannot be refined without using corrosion-resistant alloys. By use of alloys and inhibitors, operation in the Wood River refinery has been extended from 58 to 103 days to a 5½-month period and from the small amount of corrosion found during the last inspection it is probable that much longer runs can be scheduled.

Use of inhibitors has strengthened the weakest link in one refinery chain, so that shutdowns for general overhaul and repairs can now be scheduled. This permits ordering necessary replacement parts and scheduling repair crews for the most efficient utilization of manpower and for thoroughgoing inspection and overhaul at a time when there is a relatively low sales demand for distilled products.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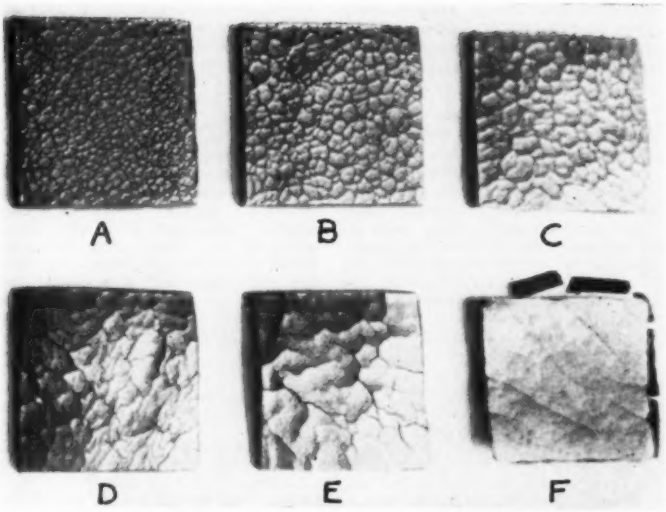


Samples of wide-range enamels showed much deterioration after immersion in gasoline. A—½ week; B—1 week; C—2 weeks; D—4 weeks; E—8 weeks; F—16 weeks.

Preliminary report on:

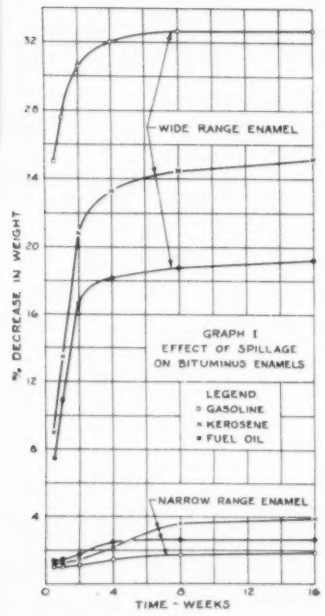
Effect of Spillage on Hot-Applied Coal-Tar Coatings

by Carl Miller*

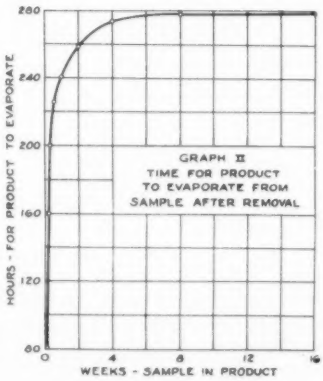
IN recent years oil-refinery and oil-pipe-line personnel have become more and more conscious of losses due to the corrosion of underground structures. Coal-tar coatings or enamels have come into common use as one method to help mitigate this corrosion.

There are, however, a few questions that need further investigation, one of which is the effect of petroleum or petroleum products on the coating. This article relates to the effect of gasoline, kerosine, and fuel oil on hot-applied coal-tar enamels. The effect of spillage of petroleum or petroleum products on corrosion protective coatings is of primary importance when such coatings are used in refinery areas or on pipe lines where spillage can occur or on lines close to other lines subject to spillage.

The coatings herein discussed fall into two classifications — narrow-range enamel and wide-range enamel. These names merely indicate the cold-check and the hot-sag temperature range of the enamels. The narrow-range enamel, those commonly used in summer months, is applicable on days with air temperature between 30° and 120° F., while the wide-range enamel, usually of the water-works type, is used between —10° and 160° F. The narrow-range enamel is manufactured from coal-tar pitch and mineral fillers while the wide-range enamel is manufactured from these same products plus additional materials and additional processing. The wide-range enamel retains most of the good qualities of the narrow-range enamel plus the ability to withstand much wider temperature ranges. There are some qualities, however, that are considerably different in the two enamels, one of which is the deleterious effect of petroleum or petroleum products.



Spillage of petroleum products has little effect on narrow-range enamels; wide-range enamels are not satisfactory for petroleum service



Procedure

In order to determine the effects of spillage the following procedure was followed. Samples (1½ by 1½ by ⅛ in.) of the enamels were prepared. The samples were all weighed on a laboratory balance and immersed in covered test jars containing either gasoline, kerosine, fuel oil, or water. Six samples of each enamel were placed in each one of the aforementioned products or water. The samples were left in the products various lengths of time from ½ week to 16 weeks; one sample of each enamel was removed after ½ week immersion, the next sample of each enamel removed after 1 week, the next group at 2 weeks, next at 4 weeks, then 8 weeks, and the last group after being immersed in the products for 16 weeks.

The samples were removed from the test solutions and after satisfactory time interval for the solution to evap-

*Sun Pipe Line Co.

orate from the sample, the samples were again weighed on a laboratory balance to the nearest milligram. The time for the product to evaporate from the sample is dependent on the length of time the sample was in the products, as indicated in Graph 2. It takes considerable time for the product to evaporate from samples that are left in the product over 1 week. For example, it takes 273 hours for the gasoline to evaporate from the sample of the wide-range enamel after it has been removed from a 4-week immersion. Graph 2 applies to any of the three petroleum products tested with wide-range enamels. The narrow-range enamels required less time for the petroleum products to evaporate. Controls were placed in a desiccator and over the 16-week period no samples decreased in weight more than .04 per cent.

Laboratory Results

A summary of the effects of the petroleum products on the narrow and wide range enamels is shown in Graph 1. In this graph, time in weeks is plotted against percentage loss in weight. The effect of kerosine on narrow-range enamel amounts to a 4 per cent weight loss after 16 weeks, while the gasoline effect is 2½ per cent loss and the fuel-oil effect is a 2 per cent loss. These enamels showed no signs of checks or cracks and from all appearances the enamels have retained all their original softness and plasticity. The effect, however, on wide-range enamels is considerably more pronounced with a loss in weight of as much as 32 per cent when a sample was in gasoline only 4 weeks. The sample, originally flexible and plastic was very brittle and full of checks after removal, as shown in the accompanying photograph.

As time of immersion increases, some of the cracks seem to heal; however, the remaining cracks develop deeper penetration. In the sample immersed for 16 weeks there are very few cracks visible at surface of enamel. However, it appears that the cohesion forces within the enamel sample have been entirely destroyed and the sample, being without strength, falls apart.

Narrow-range enamel immersed in water does not absorb more than .06 per cent by weight while the wide-range enamel absorbs about .16 per cent. It has been noted in the field, however, after a wide-range enamel was on the pipe several years, then removed, that there was slight evidence of rust but no pits. The evidence of rust was probably due to the water absorption of the enamel, but at this time the problem does not appear to be critical.

Most of us are aware of the effects of spillage on petroleum asphalt, but a few samples were placed in the petroleum products and, as expected, they were destroyed to the extent that it was impractical to make any weight measurements. The sample in water absorbed 1.72 per cent by weight after 16 weeks, but there was no visual change in the sample.

Conclusion

Tests indicate the narrow-range enamels are not affected to any great extent and can be used in refinery areas or on pipe lines subject to spillage of petroleum or petroleum products.

Wherever there is any presence of petroleum or petroleum products in the ground or there is a chance for product spillage, it can be concluded that the wide-range enamels in their present form are not entirely satisfactory for this type of service. The wide-range enamel, as represented by the so-called water-works enamel, should most certainly be used with utmost caution in refinery areas where the ground is usually contaminated with petroleum or petroleum products.

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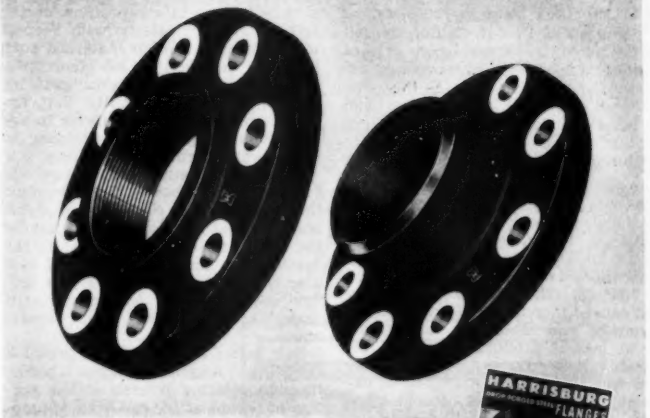

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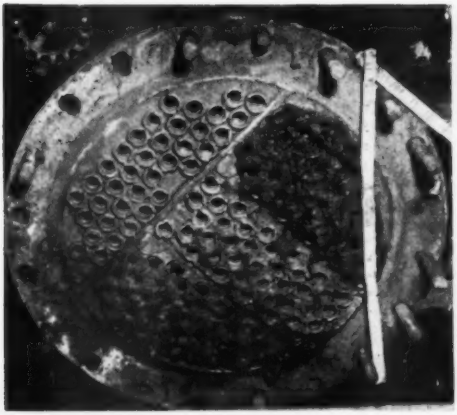

Fig. 1—Marine fouling on tube sheet.

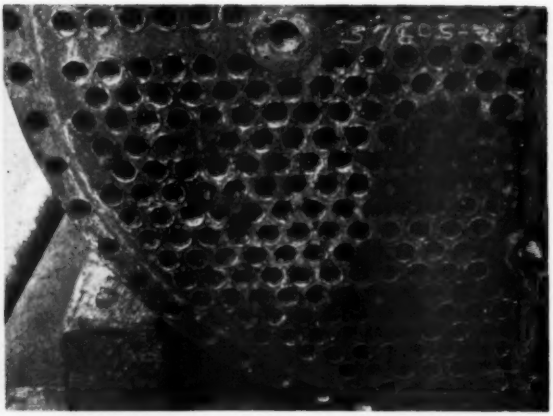

Fig. 2—Corrosion of tube ends and tube sheet.

Salt-Water Corrosion in Refinery Cooling Equipment

by Byron M. Beildeck* and O. F. Noss, Jr.*

Replacement cost at West Coast refinery was $120,000 per year prior to program of combating corrosion evils

AT the Los Angeles refinery of Union Oil Co. of California, salt water from the west basin of Los Angeles Harbor is used as coolant for a number of units. In 1949 the combination crude-oil fractionation and thermal cracking unit required 65 per cent of the total refinery salt-water consumption of 26,000 g.p.m.

In early 1950 the rate of salt-water corrosion of tubes, tube sheets, etc., in the submerged bundles and tube-and-shell exchangers at the combination unit was increasing markedly over the corrosion rates experienced in 1945-46. This increased corrosion had caused increased expenditures for materials and labor and had resulted in loss of production due to unscheduled shutdowns. An investigation was carried out in 1950-51 to determine magnitude and causes of the increase in corrosion and to study the salt-water system in as many phases as necessary to determine what changes should be made to improve the situation.

To accomplish these objectives the study was resolved into several parts. Tube-replacement records were reviewed to determine the cost and the rate of increase in salt-water corrosion. Changes in composition of the salt water, particularly with respect to undesirable foreign materials such as sand, marine life, oil contamination, dissolved oxygen, etc., were investigated. The possibility that excessive tube-skin temperatures in the exchangers might be contributing to the increased rate of corrosion was investigated through temperature traverses of open boxes. To determine the most economic consumption of salt water, a heat balance was run around the salt-water-cooling facilities at the combination unit. A number of recommendations resulted from this survey and a marked decrease in salt-water corrosion has been experienced.

Salt water from the west basin of the Los Angeles Harbor passes through rotating screens at the suction of pumps at the salt-water pumphouse and is then distributed throughout the refinery. The major portion is used at the combination crude-oil distillation and thermal cracking unit which fractionates approximately 65,000 bbl. per stream day of crude and thermally cracks approximately 35,000 bbl. per stream day of residuum and catalytic furnace oils. At this unit the water flows through a so-called "cold-water system" and a "warm-water system" in series. The cold-water system services exchangers which require a relatively low outlet temperature such as surface condensers, certain tower overhead condensers, and some product coolers. The warm-water system services exchangers which have higher temperature levels such as residuum coolers, etc.

Water from the salt-water pumphouse, ranging in temperature from 58° to 75° F., passes through twin screen filters at the unit boundary, then goes through the cold-water system. A portion of the cold water also normally bypasses directly to the warm-water system to balance the loads on the two systems. The effluent from the warm-water system gravitates to a skimming pond and then back to the harbor.

Cost of Salt-Water Corrosion

Cost of replacement of materials corroded out in salt-water service at the combination unit was determined for the period from June 1, 1947, to June 1, 1950. This replacement cost amounted to $120,000 per year for labor and materials. The cost of lost production time attributed to equipment failures caused by salt-water corrosion was not estimated.

The materials of construction for exchangers in salt-water service were originally phosphorized admiralty tubes, naval rolled brass tube sheets, steel channels, steel channel covers, steel heads, and steel stud bolts. Since 1943 when the unit was constructed, a number of test bundles of different alloy tubes have been put in service. In most cases monel, 70-30 copper nickel, and aluminum-brass tubes have failed just as rapidly as phosphorized admiralty. However, the failures have been due to the intense fouling to which the bundles have been subjected rather than the particular alloy used. Currently only phosphorized admiralty tubes are being used.

*Union Oil Co. of California, Los Angeles refinery, Wilmington, Calif.

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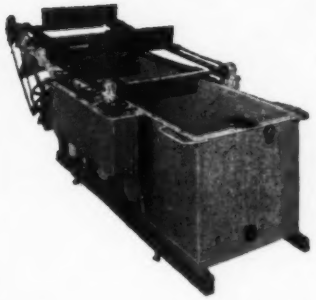

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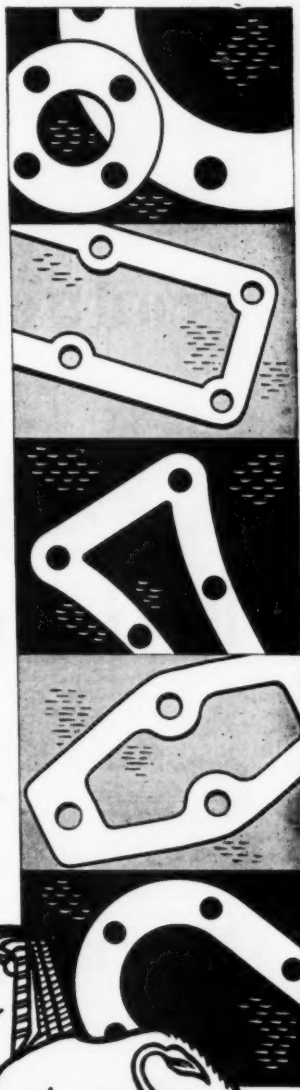

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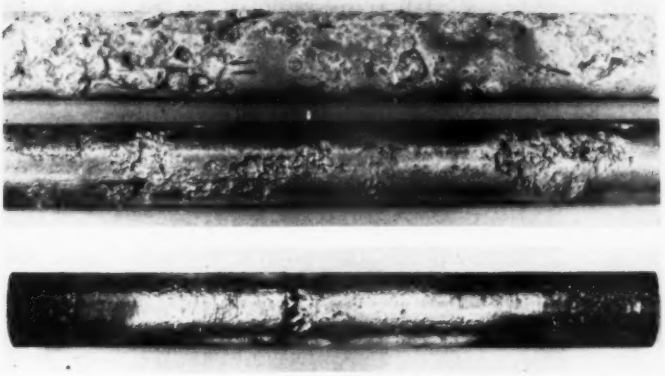

Fig. 3—(Top) Corrcsion from marine fouling.

Fig. 4—(Bottom) Baffle causing corrosion-erosion.

In submerged bundles all the steel stud bolts are being replaced with monel stud bolts. The inlet and outlet heads on submerged bundles are fabricated from monel if the pressure in the bundle is not too high. Tube sheets that have to be replaced are made of solid monel. Channel covers are now monel-lined steel.

Mechanism of Salt-Water Corrcsion

The increased corrosion rate of both tube and shell exchangers and submerged bundle exchangers may be attributed to two main causes. These are:

1. Increase in foreign matter in the salt water used for cooling, including marine life, sand, silt, dissolved gases—primarily oxygen, and hydrocarbon materials from leaks.

2. Increased duty of the exchangers resulting in higher tube skin temperatures.

These causes may be individually responsible for the increase in corrosion at some point in the salt water system, but for the most part it is believed that they collectively contribute to the increased corrosion. The corrosion resulting from various combinations of the above fundamental causes in turn manifests itself as (1) oxygen concentration cell attack, (2) erosion-corrosion, (3) hot wall effect, or (4) galvanic attack.

The preferential attack of certain local areas, causing pitting of tubes in submerged bundles or tube-end corrosion in a tube-and-shell exchanger, is known as "oxygen concentration cell corrosion." It is caused by the partial shielding of one point or area from the salt water, while other areas adjoining the shielded area are open to the depolarizing, oxygen-containing salt water. The shielded area is the anode at which corrosion takes place, and the open areas are the cathode. When a tube end is plugged with seaweed, the tube sheet which is exposed to a continuous supply of oxygen from the sea water acts as the cathode and the tube end becomes the anode. Oxygen concentration cell attack is intensified by an increase in the dissolved oxygen content of the sea water and is further aggravated by an increase in temperature.

In the event that a tube is only partially plugged and a number of the tubes in the pass are completely plugged, another type of corrosion takes place. This type, frequently called erosion, is actually erosion-corrosion and is caused by the continual formation and destruction of the oxide film on the metal tube by the impingement of high-velocity water containing dissolved gases and/or suspended solids. Both erosion-corrosion and oxygen concentration cell corrosion may occur concurrently in the same exchanger. Therefore, removal of the fouling weeds, shells, etc., is the necessary step to correct this type of attack in the tube-and-shell exchangers.

Submerged bundles are not subjected to impingement attack because of the low velocities of the salt water in the open boxes. They are subjected to oxygen concentration cell attack, however, and to what is known as the hot wall effect. This latter term was originated to describe the attack at a point on the tube wall where bubbles of gas repeatedly separate from the water. These gas bubbles prevent cooling of the metal surface and cause hot spots on the heated tube wall at the point of bubble contact. Rate of penetration at the hot spot may be 10 to 200 times the normal uniform corrosion rate.

The important factors which together accelerate corrosion at the point of bubble contact are: (1) local high temperatures, (2) high concentration of corrosive agents separating out where the bubbles form, (3) available depolarizing gases, and (4) gas composition. Since these gas bubbles separate out of the water at scratches or dents in the tube, it is very important that they be handled with particular care during installation. Operation of the bundles at as low a temperature as possible is beneficial. The use of more salt water to attain these lower temperatures may also help prevent gas bubbles from clinging to the tubes as a result of increased salt-water velocity.

Galvanic attack can occur when dissimilar metals in electrical contact are both exposed to an electrolyte. This attack was serious for the original submerged bundles which had steel stud bolts and heads in contact with naval rolled brass tube sheets. Where heads and stud bolts were replaced, monel was substituted for steel.

Increased Oxygen Content of Salt Water

In the fall of 1947 the Los Angeles Harbor Commission undertook a program of cleaning up the harbor water,

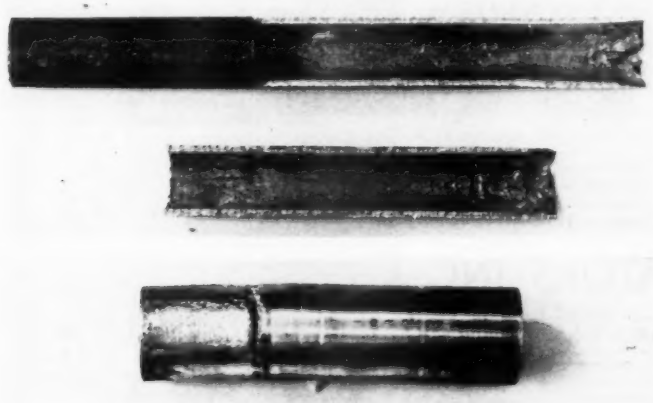

Fig. 5—(Top) Corrosion-erosion in tube ends.

Fig. 6—(Bottom) Gas leaking at tube sheet.

one objective of which was to prohibit the influx of contaminants with a high oxygen demand. At that time the dissolved oxygen content was approximately 1 p.p.m. or less. By 1950 the dissolved oxygen content had risen to approximately 4 p.p.m.

Solubility of oxygen in sea water exposed to air at atmospheric pressure decreases with increasing temperature. Salt water at 125° F. is saturated with oxygen at a concentration of 4 p.p.m. If the present salt water from the west basin, containing 4 p.p.m. dissolved oxygen, is heated above 125° F., formation of gas bubbles results, with corresponding possibility of occurrence of the hot wall effect. Water used in 1947, showing a low dissolved-oxygen content, could be heated in excess of 150° F. before gas bubbles formed.

Marine Life in Salt Water

The increased oxygen content has fostered an increase in marine life of the harbor water. The problem of shells and seaweed in the salt water stream has materially increased corrosion of tube ends and tube sheets in tube-and-shell exchangers. Marine fouling on tubes in submerged bundles has also resulted in corrosion problems.

In Fig. 1 is an example of the marine fouling that has occurred on a number of the tube sheets of tube and shell exchangers. Fig. 2 shows the corrosion to the tube ends and tube sheets resulting from marine fouling. Fig. 3 indicates the corrosion from marine life fouling on the salt-water side of tubes in submerged bundles. These photographs indicate the importance of adequate facilities for removing marine life from salt water before its use as a cooling medium, or as an alternative, provision for removing same from exchangers or submerged bundles at frequent intervals as they become fouled. This is being done through the use of finer-mesh screens, facilities for backflushing certain exchangers, and an accelerated maintenance program involving frequent cleaning of exchangers.

Originally screens at the salt-water pumphouse were two-mesh and those at the combination unit four-mesh. Failure of the latter frequently permitted marine life to reach exchangers. Currently, eight-mesh screens are in service at the salt water pumphouse and 20-mesh screens at the unit.

The installation of facilities to permit occasional reversing of the flow through exchangers to remove marine life collecting on tube sheets has been given consideration, but in most cases it is not considered feasible. However, for certain exchangers in the cold-water system which have a back pressure at the outlet, a valving arrangement has been installed in the inlet line to permit backflushing to sewer.

An aggressive policy involving frequent cleaning of tube-and-shell-exchangers by the maintenance department is also being carried out to prevent the accumulation of marine growth and thus prolong life of the bundles. The inlet end of tubes in tube-and-shell exchangers have been protected by inserting plastic tube-end protectors. Chlorination of the incoming salt water to prevent marine growth in the line between the pumphouse and the refinery units is also being considered.

Heat Balance and Temperature Studies

The possibility was investigated that excessive tube-skin temperatures on exchangers in salt-water service might be contributing to the increased rate of corrosion. That tube-skin temperatures of the combination unit were higher in 1950 than in previous years appeared quite logical because the crude-oil rate had increased from the design rate of 46,000 bbl. per stream day in 1945-46 to 65,000 bbl. per stream day in 1950. Fresh-feed rate to the thermal cracking section had also increased.

Heat balances were made on all of salt-water-cooling equipment at the unit to determine quantity of salt water used and distribution within the unit. The quantity of salt water consumed by the unit amounted to 18,500 g.p.m. with an inlet tempera-

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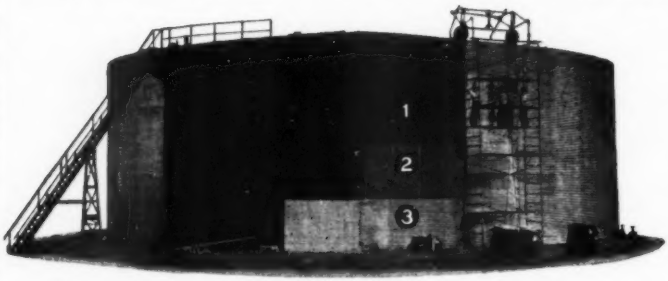

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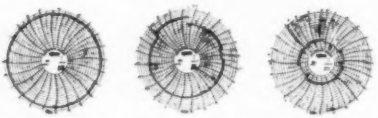

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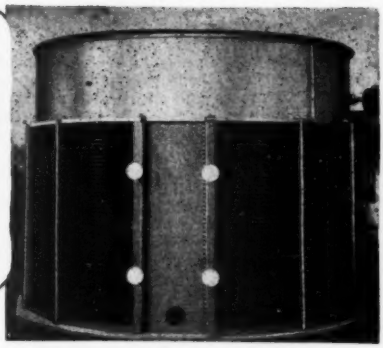

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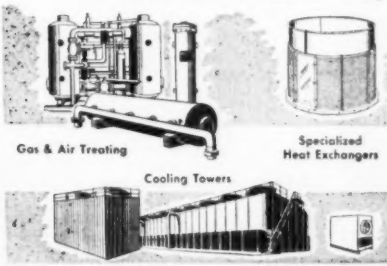

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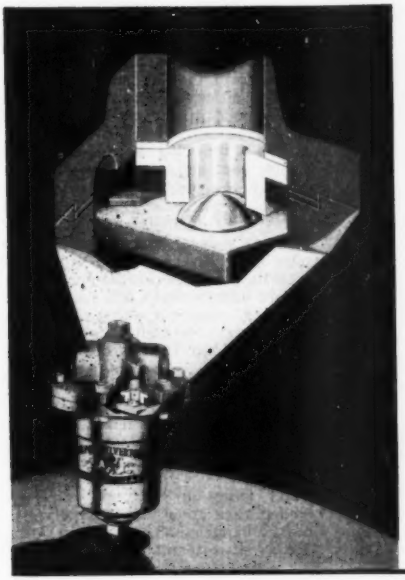

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ture of 68° F. and an average outlet temperature of 124° F. The heat balance showed a number of submerged bundles which were operating with salt-water-outlet temperatures between 130° and 140° F. Some of the tube-and-shell exchangers had outlet salt water temperatures above 125° F. at which temperature dissolved oxygen above 4.0 p.p.m. would be released. Other exchangers using warm water had outlet temperatures around 110° F. This indicated a need for better control of rates and discharge temperatures to reduce corrosion in those bundles previously exposed to excessive temperatures.

With high temperatures in most of the open boxes, temperature traverses were made throughout all salt-water boxes to study the stratification of the salt water. Thermocouple readings were taken at 2-ft. intervals from bottom to top and at different locations in the boxes. There was a definite temperature gradient from bottom to top of the box. However, at any given depth of liquid there was little variation in temperature throughout the box in spite of the fact that water entered it at one end and left at the other. Apparently the incoming water flowed along the floor of a box and rose by thermal convection through all the bundles, then flowed across the top layer to the outlet weir. The severe stratification occurring in several boxes offered an excellent opportunity for corrosion of the first-pass tubes in the hot top layer of water.

Based on information gained through temperature studies, a number of changes in the operation of the salt-water system were put into effect. Sufficient salt-water pumping capacity was available to increase the rate of the combination unit from 18,500 to 26,000 g.p.m. With this new water rate, the outlet temperature of all cold-water exchangers could be controlled between 90° and 100° F. Similarly, all salt water leaving the warm-water exchangers could be controlled between 110° and 120° F. with the temperature preferably 115° F. or lower. The outlet temperatures were indicated by installing dial thermometers in certain strategic locations.

The inlet pass on submerged sections as originally designed was in the top layer of warm water. Thus, the hottest part of the section was in contact with the highest-temperature water, resulting in abnormally high metal temperatures. To reduce the severity of this condition, the heads on the bundles were reversed so that the first pass was placed at the bottom of the box thereby lowering tube-metal temperatures. By reversing the heads and increasing salt-water rate, water flow pattern within one box actually changed to a point where a temperature profile indicated a "rolling" action.

Miscellaneous Factors

A number of undesirable conditions, for the most part pertaining to only particular exchangers or cooling boxes at the combination unit, rather than to the salt-water system as a whole, were noted during the course of the survey.

It was discovered that an atmospheric vent on the water line leaving one of the surface condensers was the source of a large amount of dissolved or entrained air in the water entering a given open box. The purpose of this vent was to protect the transite line between the surface condenser and the open box from "steam hammer" during a startup. The vent was relocated so that air could not be entrained and the dissolved oxygen concentration in the water to this box was reduced to 50 per cent of its original value.

In the case of a number of condensers located 20 to 40 ft. above ground elevation, salt-water flow was controlled by the inlet valve, and water falling in the outlet pipe created a vacuum in the second pass of the exchangers. The vacuum released dissolved air and caused corrosion throughout the length of tubes (see Fig. 5). This condition was remedied by controlling the salt-water flow by valves on the outlet, rather than the inlet of exchangers, thus maintaining a positive pressure on the water side throughout.

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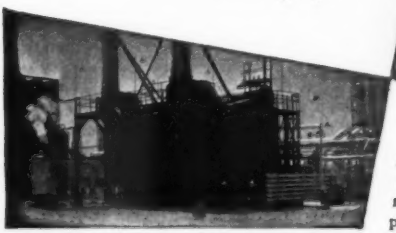

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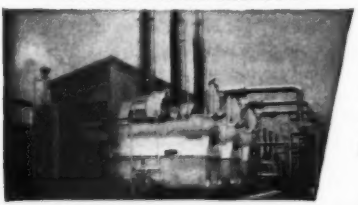

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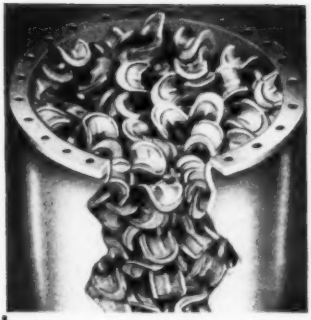

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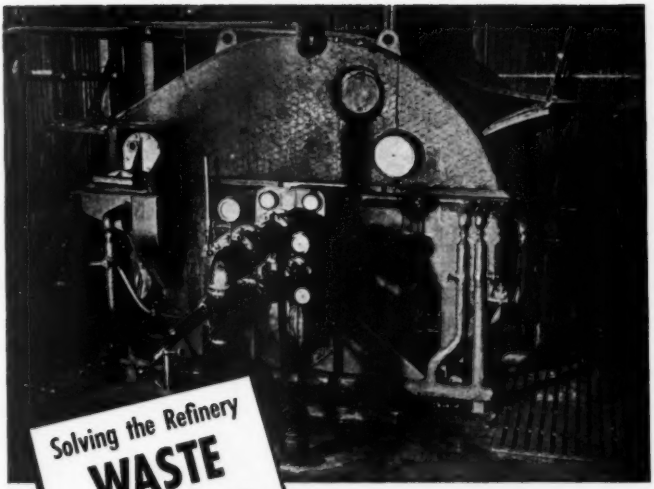

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Oliver United engineers, calling on their 42 years of filtration experience and their many varieties of filter types, developed this closed type, continuous vacuum precoat filter for handling refinery wastes. It's proving a boon to refineries in connection with this vexing problem.

A letter or phone call to our nearest office will have a skilled refinery filtration engineer at your plant whenever desired to make a study and recommendations for a filtration plant to handle the wastes properly.

• • •

Another very profitable use of the Oliver Precoat Filter in refineries is in connection with contact clay handling. Many are in service providing continuous handling, great reduction in oil losses over other methods, and more easily handled cake.

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marine life and oil sometimes collected on the surface of the open boxes because of ineffective skimmers. A portion of this material would ultimately sink down on a bundle and cause oxygen concentration cell attack. Installation of large U-shaped skimmers successfully removed debris from the surface to alleviate this problem.

Some corrosion problems have been attributed to the fact that submerged bundles were removed from service or returned to service while a marine life or oil scum was floating on the surface of the open box. Where this scum clung to the outside tube wall, oxygen concentration cell attack occurred with eventual failure of the tubes. In event that a bundle must be removed from or replaced in an open box, it is now standard procedure to make certain that the surface of the open box is clean before the tubes pass through the surface.

It had not been the policy to immediately remove a leaking exchanger from service. If there was a roll leak in a submerged bundle, the gas passing up along the tube sheet would set up a hot wall effect and the tubes would be cut as shown in Fig. 6. Now, when a leak is detected, the bundle is removed from service as soon as feasible. All exchangers have always been inspected in a predetermined manner during scheduled shutdowns.

Process Changes

There are a number of submerged bundles which have had extremely short life due to excessively high inlet temperature of the hydrocarbon stream. Analysis of these data has yielded a correlation between the average tube-metal temperature and the tube life. To lower the inlet hydrocarbon temperatures to the point that satisfactory tube life can be expected, a number of process changes are contemplated within the unit. One salt-water cooler has already been removed from service and the hot stream, formerly going to this unit, now passes through the hydrocarbon side of a steam generator which was normally bypassed in its previous service. Other streams will also generate steam, preheat heater charge streams, or preheat boiler feed water. Most of these changes have a short payout based for a large part on heat recovery.

Conclusions

The beneficial effect of many of the recommendations resulting from this survey has been noted during the past year. During a recent shutdown, certain salt-water exchangers which were scheduled for retubing based on prior history were inspected and placed directly back in service when the tubes were found to be satisfactory. Other boxes have experienced a decided tapering off in the required number of retubings.

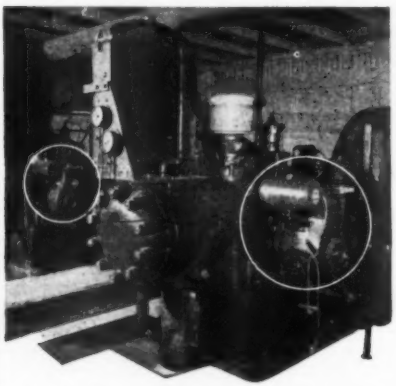
Protectors are preventing corrosion at the ends of the tubes. Backflushing, more effective screening, and more frequent cleaning are protecting the inlet ends of the passes on tube and shell exchangers. The backflushing alone has shown several instances of improved heat transfer between cleanings. Placing the inlet passes at the bottom of the open box has helped certain bundles. Other exchangers are experiencing longer life because the salt water flow is controlled by the outlet valves. More efficient skimmers are keeping the surface of the open boxes clean.

Probably the most important single factor in reducing corrosion is the reduction of the outlet temperatures of the warm salt water exchangers to maximum temperatures of 120° F. with the temperatures usually under 115° F.

Acknowledgment

Paper presented at the California Natural Gasoline Association fall meeting.

The authors wish to thank Union Oil Co. of California for permission to release the findings of the survey. Also, the authors wish to acknowledge the cooperation and assistance from various personnel within the refinery staff, especially the men of the cracking department and the engineering inspection group.



POWER TO FIT THE MACHINE

POWER TO FIT THE JOB

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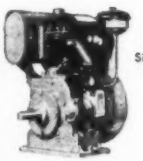
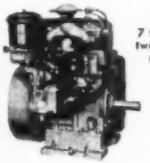
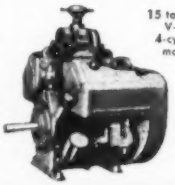


6 to 9 hp. Single-cylinder models.



7 to 13 hp. two-cylinder models.



15 to 30 hp. V-type 4-cylinder models.

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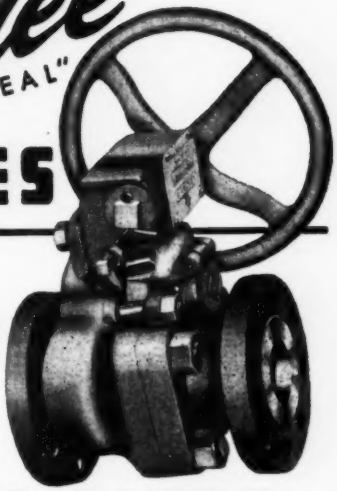

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Magnolia Reduces Furnace Corrosion in Polyformer

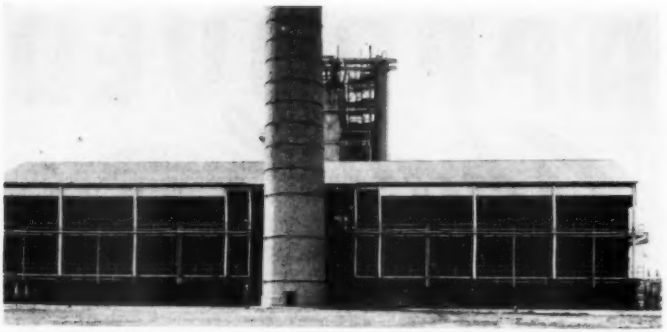


Fig. 1—Magnolia Petroleum's two polyform furnaces have a common plenum chamber and stack. Each furnace has a duty of 100 million B.t.u. per hour.

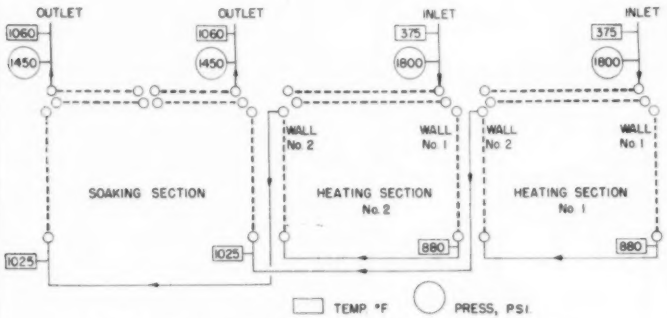


Fig. 2—General arrangement of polymerization furnace.

Higher-alloy furnace tubes and header material have been installed in the polyform furnaces at Beaumont, with these results:

1. **Corrosion of equipment reduced.**
2. **Maintenance costs lowered.**
3. **Increased stream time — from 30-60 days to 135 days. Possible 150-180 days in near future.**

by J. J. Baker*

THE polyform unit at Magnolia Petroleum Co.'s Beaumont refinery was built in 1941 for the conversion of straightrun, naphtha and extraneous light hydrocarbons into motor gasoline. The unit employs two main furnaces, one for cracking the gaseous hydrocarbons and the other for promoting polymerization and condensation reactions. The charge to the polyform furnace consists of naphtha and from 80 to 100 per cent its volume of propane, and the charge to the polymerization furnace consists of light hydrocarbons.

Furnace Operation

These furnaces, of 100 million B.t.u. per hour duty each, are similar in design. They are floor fired from a raised hearth and have a common plenum chamber and stack (Fig. 1). Each furnace consists of two radiant-heating sections and one radiant soaking section. Flow through each furnace is in two equal and symmetrical streams, first through the upper roof, lower roof, and side walls of the heating sections, and then through the side walls and roof of the soaking section. Each heating section has 20 upper-roof tubes, 20 lower-roof tubes, and 16 tubes on each side wall, while the soaking section has 24 tubes in each roof section and 16 tubes on each side wall.

Flow diagram, tube layout, and operating conditions for the polymerization furnace are shown in Fig. 2. Tubes, 5½ in. o.d. by ¾ in. average wall by 40 ft., are used throughout the furnaces with the tube ends upset both internally and externally.

Corrosion in both furnaces may be expected since none of the sour feed streams are treated to remove the hydrogen sulfide or other corrosive agents. The sulfur content of the furnace charge is 0.4 per cent (weight) for the polyform furnace and 0.5 per cent for the polymerization furnace.

The corrosion experienced in these furnaces is of the type commonly known as high-temperature sulfide corrosion and follows a definite corrosion-temperature relationship. At 550° F., corrosion becomes noticeable and reaches a maximum at 750° F. Corrosion decreases at higher temperature and is relatively low at 900° F. This corrosion-temperature relationship is shown in Fig. 3 by the curve for steel containing 2 per cent chromium and ½ per cent molybdenum (2 Cr.-½ Mo).

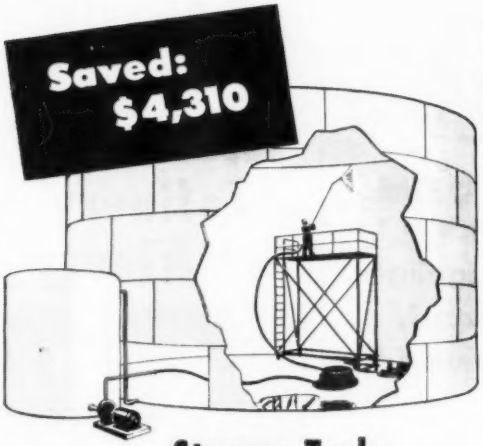
Alloys for Tubes

Alloy steels originally used in the polymerization furnace were:

Heating sections:	
Upper roof	2% Cr.-½% Mo.
Lower roof	2% Cr.-½% Mo.
Side wall No. 1	2% Cr.-½% Mo.
Side wall No. 2	2¼% Cr.-1% Mo.
Soaking section:	
All tubes	2¼% Cr.-1% Mo.

Corrosion of the original 2 per cent Cr.-½ per cent Mo. tubes in the heating sections operating in the critical temperature range of 550° to 900° F. soon became evident after the unit began operating. The corroding tubes were in the outlet portion of the upper roof, in the entire lower roof and on side wall No. 1. Although corrosion is of little consequence above 900° F., the soaker and the outlet portions of the heating sections contain 2¼ per cent Cr.-1 per cent Mo. tubes because of the severe operating conditions. The corrosion rates of the 2 per cent Cr.-½ per cent Mo. tubes are shown in Fig. 3. Progressively higher alloy tubes were tried as replacements in the corroded sections. Following this plan, tube alloy ma-

*Engineering department, refining division, Magnolia Petroleum Co., Beaumont, Tex.



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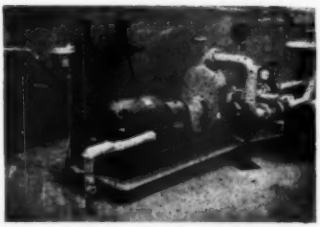
MARLOW pump adds to new refinery efficiency



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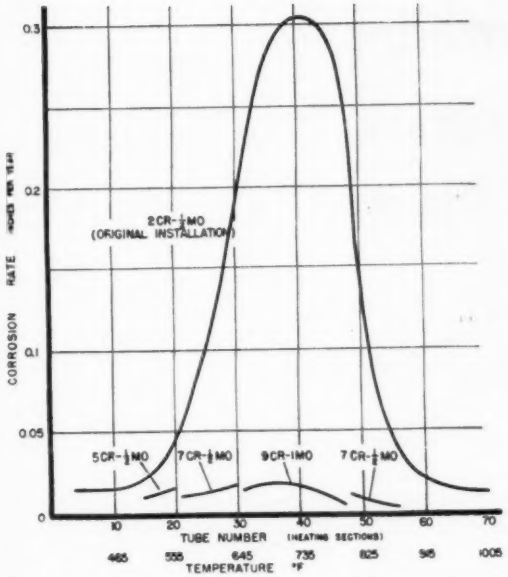

Fig. 3—Corrosion rates of alloy steel tubes in polyform service.

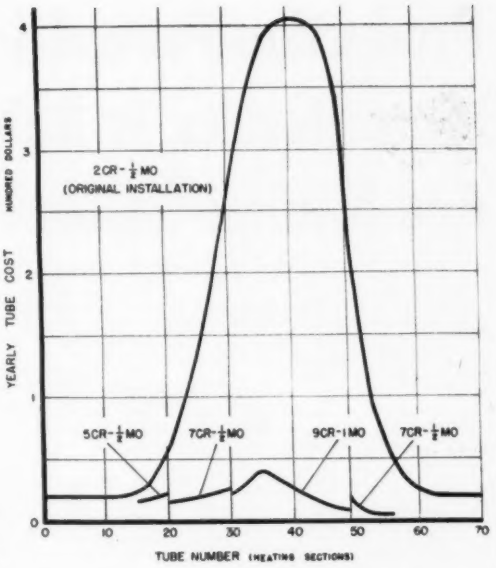

Fig. 5—Yearly tube costs for alloy-steel tubes in polyform service.

terials now used in the heating sections are:

Tubes:	
1-14	2% Cr.-½% Mo.
15-20	5% Cr.-½% Mo.
21-30	7% Cr.-½% Mo.
31-48	9% Cr.-1% Mo.
49-56	7% Cr.-½% Mo.
57-72	2¼% Cr.-1% Mo.

The corrosion rates with these alloy materials are shown in Fig. 3 with the relative costs of the alloy tubes shown in Fig. 4. By combining the curves of corrosion rates and relative costs, the curve in Fig. 5 was developed. This curve gives the cost per year per tube. Actual savings are indicated by the difference between the curves of the 2 per cent Cr.-½ per cent Mo. and the higher-alloy tubes in Fig. 5.

Through the gradual replacement with higher-alloy tubes, it was noted that:

1. Low-alloy tubes, when surrounded by much higher-alloy tubes, showed an increase in corrosion rate.

2. High-alloy tubes shift corrosion to the higher-temperature portion of the corrosion-temperature curve.

The corrosion in the tubes is greatest at the ends except for tubes immediately preceding the most corrosive sections in the heaters, where the tubes thin towards the middle. This may be explained by assuming that the film of oil in contact with the tube wall reaches the corrosive

(Continued on page 316)

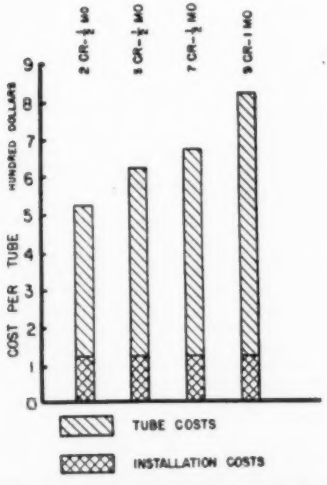

Fig. 4—Tube and installation costs for alloy-steel tubes in polyform service.

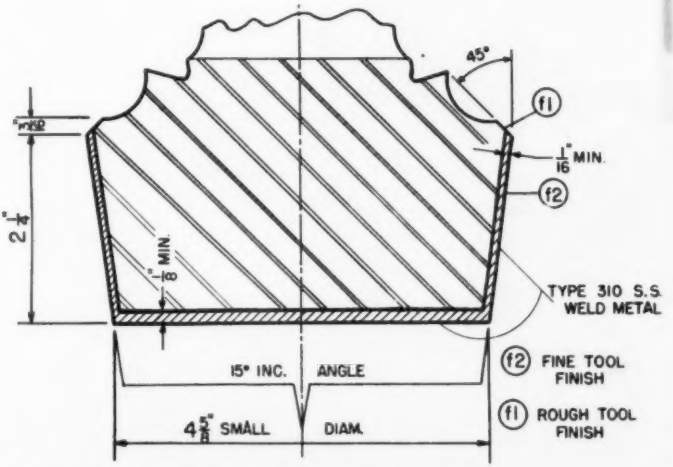

Fig. 6—Repaired furnace header plug.

Production-Proved Inhibitor Gets Results in Refineries And Natural-Gasoline Plants

by Forrest E. Love*

AN organic corrosion inhibitor which has been used successfully for several years in combating oil and gas-well corrosion is showing excellent results in crude-oil refineries and field processing operations. The material was initially tried out in a refinery in December 1949.

Results of this initial tryout were sufficiently encouraging to justify trials in other plants. Subsequently the material has been used in refineries all over the country to afford protection in practically every kind of refining process and against most types of corrosion encountered by refiners. A possible exception is high-temperature furnace-tube corrosion.

A brief summary of the different installations where the material, Kontol, manufactured by Tretolite Co., is in service, is given in the following paragraphs.

Refinery "A"

Debutanizer heat exchanger.—Catalytic cracked feed from an absorber entered the debutanizer at 200 psi. and at 230° F. Throughput was 5,000 bbl. daily of gasoline and 1 bbl. of water. The exchanger was steel-tubed, and corrosion was so severe retubing was necessary every 3 months or sooner. The inhibitor injection was started at a rather high rate. The test was controlled by the iron content of the water, caught in a water trap installed in the line from the exchanger. As the iron content decreased the amount of Kontol used was also decreased.

After more than 2 years this exchanger is still in service. During this time the throughput has been increased from 5,000 to 9,000 bbl. per day. One gallon of Kontol is injected daily at the present time; a ratio of 1 to 378,000. The unit has not been shut down except for inspection during this period.

Refinery "B"

Thermal gas plant.—Since the inhibitor is nonvolatile, if a vapor line is to be protected, it must be dispersed in the vapors. In this refinery, Kontol was proportioned into the gas plant in four places; the wet incoming gas stream, the overhead vapors from the primary and secondary steam stills, and the overhead vapors from the debutanizer. Thus the overhead lines were protected, and the inhibitor being present in the condensate, the condensers and accumulators were protected. The reflux lines and pumps from the accumulators carrying inhibited reflux to the tower afforded protection to the trays and tower. The still bottoms carrying the inhibitor protected the absorber as well as the lean-oil exchangers and connecting lines. Flow arrangement of this thermal gas plant is shown in Fig. 1.

For a cost of $9.00 daily, 21 heat exchangers, 6 accumulator drums, 6 pumps, 2 stills, and an absorber with all connecting lines were protected. At the end of a 9-month run, the plant came down for cleanout and inspection. Heat exchangers were clean and showed no evidence of corrosion; all towers were cleaner with less loss of metal than on previous cleanouts; pitting which had occurred before use of the inhibitor had stopped and no new pits were formed; bubble caps and trays, normally corroded, showed evidence that corrosion had halted—none were replaced.

The trays contained a large amount of loose scale at this inspection. This is a normal situation and is to be expected since Kontol has a definite detergent action, causing the scale to slough off during treatment. The scale can usually be disposed of by back washing.

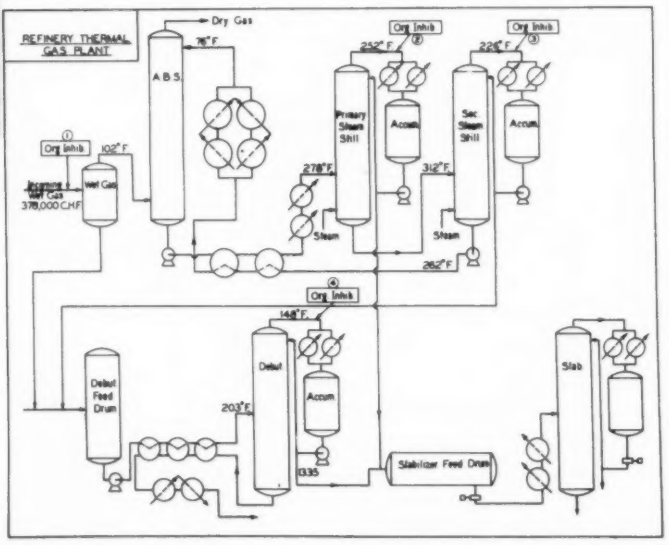

Fig. 1—Flow layout of thermal-gas absorption plant showing locations of inhibitor injection points.

Refinery "C"

Topping unit.—This type service is the most common usage of the inhibitor in refineries. The problem is a familiar one to all refiners. The chlorides and sulfur compounds from the crude oil are released as a corrosive vapor attacking the tower, overhead lines, condensers, accumulators, and other metal parts of the system. A common practice is injection of ammonia into the vapor line to combat the corrosive acid compounds. Success of this method depends on maintaining a constant pH, which is usually a difficult task. A pH above 8.0 affects the alloys containing copper and zinc, and a low pH does not give protection to the steel and iron parts of the unit.

A topping still in an Indiana refinery having 3,500 net bbl. per day of overhead is protected by 1 qt. of Kontol inhibitor daily, injected into the overhead vapor line. The nonvolatile inhibitor remains with the condensate to protect not only the overhead lines and condensers, but the accumulator, reflux pumps, and trays as well. This unit has been protected for 2 years with no evidence of corrosion in the entire system.

Refinery "D"

Light-oil unit.—In an Illinois refinery where the inhibitor is used in a

*Tretolite Co., St. Louis.

topping unit and light-oil fractionator, "the straightrun gasoline streams have all shown improvement; iron copper and zinc losses are lower with Kontol than with only ammonia. Ammonia is now used as required to keep pH to 3.5-4.5. The unit was inspected after 125 days of operation, and results were quite satisfactory."

In this plant, as in others, it was found that on initial application the detergent action of the inhibitor cleaned old scale and other corrosion products from the unit, causing an extra high iron content in the water present. After coating was complete, and protection established, the iron content of the water was reduced to about 1.5 p.p.m.

Refinery "E"

Sulfuric acid alkylation unit.—Considerable difficulty with loss of heat transfer rates on the rerun tower reboiler of the alkylation unit was experienced in this refinery. Rapid deposition decreased transfer rates rapidly, necessitating frequency cleaning and abnormal quantities of steam for heating. Detergent action of the inhibitor prevented most of the deposition. Although a thin coating of material deposited on the tubes of the reboiler, plugging was halted and heat-transfer rates leveled off to an economical figure.

Natural-Gasoline Plant "F"

High compression system.—In this natural-gasoline plant, wet gas from the field containing 3.6 M.c.f. gasoline, zero to trace H_2S, and from 0.5 to 1 per cent CO_2, is compressed to 550 psi. and cooled to remove condensate of hydrocarbons and water, further compressed to 1,000 psi. and distributed to injection wells.

Severe corrosion occurred between the cooler and separators, and inhibitor was batched into the high-pressure system daily. Test coupons inserted in the top of the cooling coils showed corrosion rate decreased from 80-90 MPY (mills penetration per year) to 3-4 MPY after use of Kontol.

Very good protection was obtained at the rate of 1 gal. of inhibitor to 10 M.M.c.f. gas. Subsequently the rate has been reduced to 1 pt. daily or at the ratio of 1 gal. per 45 M.M.c.f.

Natural-Gasoline Plant "G"

Steam stripping still.—In an Illinois plant the hydrocarbon is stripped from the absorber oil with steam. The gas contains from a trace to zero H_2S. The presence of water at the still temperature created a severe corrosion condition. Inhibitor injected into the reflux line entered the top tray of the still and afforded protection for the tower walls and trays.

Iron content of the water drawn from the still showed a reduction of about 97 per cent at an inhibitor-reflux ratio of 1 to 60,000. Inspection

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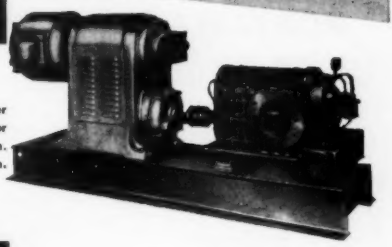

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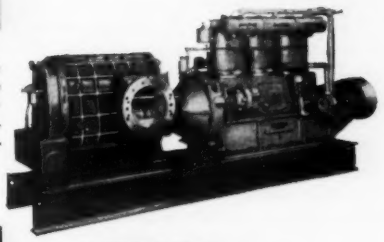

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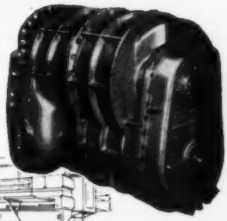

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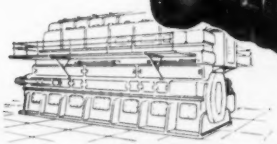

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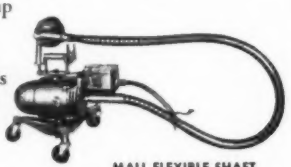

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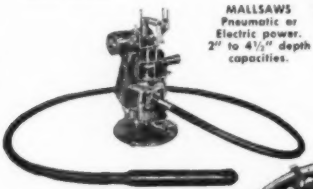

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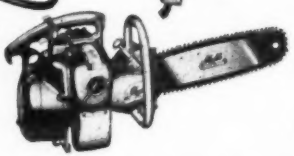

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of the equipment showed no evidence of further corrosion after nearly 2 years of protection.

Methods of Application

Experience has shown that a ratio of 1 gal. of Kontol inhibitor to 2,000-2,500 bbl. of hydrocarbon will prevent corrosion after the protective coating has been established. It has also been shown that the most effective method of cleaning the equipment and establishing this protective coat is by "slugging" the inhibitor into the system at approximately four times the normal or calculated ratio during the first 5 to 7 days. The amount of inhibitor is then reduced by half, and the "batching" continued for another 5 to 7 days, or until the iron and sludge content of the water is materially reduced. Following this coating of the equipment, the normal dosage is injected continuously.

The inhibitor is usually mixed with a hydrocarbon for better distribution and ease of pumping and measuring. It is readily soluble in kerosine, diesel fuel, or gasoline, and to a lesser degree in the lighter cuts.

Since the percentage of inhibitor used is very small, the best possible dispersion and mixing should be obtained. Where injection is into a vapor line, the zone of greatest turbulence should be selected as the injection point.

Line-inserted test coupons examined periodically show successful control for production and pipe-line use. Chemical analysis of water from the system has proven reliable as a control in refining practice. The final answer, however, lies in the metal inspection and service record of the equipment being protected.

Tests and experience have shown that the inhibitor does not affect the octane rating of gasoline. It does not show evidence of any deleterious effect by the standard tests of petroleum products, except for a slight reduction in color rating. This reduction is less than one Saybolt color number when mixed directly with the gasoline or kerosine. In practice the color usually shows an improvement due to the elimination of corrosion products. When used in catalytic feed stocks the inhibitor does not affect the catalyst. Tests are being made at the present time on petrochemical installations, and results are promising.

"Overcoat" For Pipe Line

An unusual pipe line with its own heating system has been built in Texas to carry a very viscous crude oil. The carrier has a 2-in. flow line jacketed by a 4-in. pipe through which hot water is circulated. The whole is encased in magnesia insulation. The line runs from a new oil well into a gathering system.

Case Histories of Corrosion Problems and Use of Protective Coatings in Their Solution

Corrosion substantially mitigated in numerous instances at Gulf Oil Corp's Port Arthur refinery

by W. B. Cook*

1. Interior Tank Corrosion

SINCE large quantities of sour crude are received and processed at Gulf Oil Corp.'s Port Arthur refinery, interior corrosion of tankage in sour-oil service is a problem that has been given a great deal of attention for a number of years.

Although several means, such as the use of gunite linings, floating-roof tanks, and special materials of construction, are known to offer good resistance to sour-oil corrosive attack, these methods are initially high in cost, and in some cases maintenance has been a problem. Therefore, test applications of promising newly developed protective paint coating systems to the interiors of conventional cone-roof tanks continue to be made with the object of establishing a comparatively low-cost system of protection that will afford a decided economic advantage.

Gulf's records indicate that uncoated, large (80,000-bbl.) sour-crude storage-working tanks will develop small holes in the roof from interior corrosion after 2 to 3 years' service which may be patched from time to time to give a total roof life of approximately 5 years before requiring replacement. In some cases it is necessary to replace the top ring of the shell and a portion or all of the roof-supporting members when a new roof is erected. However, if inspection indicates that this ring and the roof-supporting members will last the life of the new roof they are not replaced.

Lower rings of the shell are replaced as inspection indicates. Action regarding the tank bottom is determined by inspection, and when deemed advisable for continued service of the tank, the old bottom is either replaced or reinforced by a layer of tar paper and hot-applied pitch over which several inches of concrete may or may not be poured.

Uncoated roofs of sour-distillate rundown tanks (40 ft. diameter by 10 ft. high or 36 ft. diameter by 12 ft. high) must be renewed after periods of 3 to 4 years' service depending on the corrosiveness of the distillate. Shells and bottoms of these tanks are replaced in periods ranging from 6 to 10 years, some of which are protected for a portion or all of this time with brick lining of the shell, and/or with gunite or tar paper-hot pitch-concrete over the steel bottom.

A cost-durability study made in 1948 of sour-crude tank roofs, the underside of which had been sand blasted and coated with a two-coat coal-tar primer-mastic system during a prior 8-year period, showed that the application of this coating system was costing slightly more than was justified by the extention of about 1 year of the time in which an uncoated roof was required to be replaced.

Cost-durability studies, made also in 1948, of this coal-tar coating system and others, such as air-drying phenolics, applied to the vapor space interiors of sour distillate rundown tanks showed that these applications were not economically advantageous.

Since the vinyl type of coatings was being applied quite extensively on a test basis on the interior of stock tanks in the West Texas producing field during 1946, and these appeared to have qualities such as elasticity and resistance to abrasion, gasoline and chemical attack, it was decided to do some refinery field testing of typical materials of this type appearing to offer promise.

In February 1947, spray application of a four-coat system of a vinyl type liquid coating which dried to a rubber-like film, was made to the entire surface of rafters, roof support, underside of roof, and interior of shell of a 36 ft. diameter by 12 ft. high, riveted-steel, rundown tank after thorough sand blasting to bright metal. This tank was in sour-naphtha rundown service for a year and a half and was then out of service but filled with brackish bayou water for the next 3 years.

No inspection was made of this coating application until July 1951, approximately 4½ years after application was made, after cleaning by water flooding prior to putting the tank back into distillate service. This inspection showed the coating to be approximately 95 per cent intact. Above the salt-water immersion level, there was no heavy surface deposit and the white finish coat had discolored only to a grayish-brown.

In two places underneath the roof near the edge and on one side of one of the channel rafters near the center, the coating film had peeled away from the steel and was hanging down in sheets of about 1-sq. ft. size. Specimens of this, torn loose, were quite pliable and tough and had the appearance and feel of a sheet of rubber. The steel at these peeled places was in good condition, with only mild rusting having occurred. It is thought that this peeling developed from breaks in the coating which started from small blisters originating from pin holes in the coating film since two small (2 to 3-in. diameter) and one rather large (approximately 6-in. diameter) blisters were also observed in the coating on the underside of the roof.

Vinyl Coating Repeated

The portion of the surface below the water-immersion level was covered with a brown deposit which could be scraped away to reveal the coating to be intact with no blistering and with only slight peeling having occurred near the bottom angle. The coating on this portion, however, appeared to be somewhat thin in a few places. In view of the good condition of this coating and the protection it had afforded through 4½ years of contact with sour naphtha and salt water, the peeled and blistered spots were cleaned with hand motive tools and recoated with the vinyl-type coating system prior to reentering the tank into distillate service.

This same coating system was applied after sandblasting, to all interior steel surfaces above and including the top ring of one-half of a 140-ft. diameter by 30-ft. high 80,000-bbl. sour-crude storage-working tank in June 1947, the roof of which had been replaced, for comparison with the other half which was coated with a

*Gulf Oil Corp. Port Arthur Refinery

two-coat coal-tar primer-mastic system. Exterior inspections of this roof has revealed that two small holes caused by corrosion from the underside developed through the roof plates coated with the coal-tar system in 3 years' time, while no corrosion through the plates from the underside has been observed to date on the section coated with the vinyl material after 4½ years of service. No inspections of the interior of this tank have been made since application of these coatings, as it has been in continuous service since that time.

A five-coat vinyl coating system was applied to the entire under side of a new roof, rafters, and inside of the old top ring of the shell of another 140-ft. diameter by 30-ft. high 80,000-bbl. sour-crude storage-working tank in June 1948. The sandblast surface preparation and coating application technique was very closely supervised and one of the most highly recommended brands of vinyl-type coating systems for this purpose was used, which resulted in a comparatively high cost per unit area of surface coated. Continuous service of this tank has not permitted interior inspection, but there has been no indication of failure to date after 3½ years of service.

Five-Coat Vinyl System

Another five-coat vinyl system that appeared to have a great deal of promise for protecting steel in sour-oil service was applied to the interior surface, with exception of the bottom which was gunited, of a new 40-ft. diameter by 10-ft. high, sour-distillate rundown tank in January 1948. This tank was in sour-distillate service, a great deal of which was partially filled static storage, for 2½ years of a total of 3 years and 4 months before being opened for inspection. It was either empty or partially filled with water during intermittent short periods for the other 10 months of this total period. No steam was used in cleaning and gas-freeing the tank since it is known that temperatures of about 160° F. or above will blister the vinyl coatings.

After being emptied, the tank was flooded with water and the entire inner surface was hosed down with water through the manhole to gas-free for interior inspection. Most of the coating film had apparently remained loosely attached to the shell plates until shortly before this clean-out as inspection showed that the hosing operation had broken and dislodged a large amount of the complete film and washed it down on to the bottom of the tank in rather large sheets. Close examination of the steel showed only mild rusting and practically no pitting of the shell plates, although some mild pitting had occurred on the roof plates and rafters. There was a thin layer of soft scale formation on most of the roof plates and rafters. Hard scale appeared only along the top edges of some of the rafters.

This inspection indicated that the coating had probably afforded very good protection in the vapor space area for at least 2 years and to the shell for probably 6 months or more longer. Failure of the coating after this length of time was attributed to loss of adhesion caused by formation of corrosion products underneath the film since specimens of the multi-coat film itself appeared to have adequate protective qualities. Possibly corrosion product formation underneath the coating film resulted from small amounts of aerated moisture entrapped during application of the primer coat. It is thought that a more inhibitive pigment in the primer coat might have been beneficial in this respect.

This same five-coat system was applied to the renewed rafters and roof of still another 36-ft. diameter by 12-ft. high tank for sour-distillate service in March 1949. The previous roof of the tank in this particular service, considered to be the most severe of this type in the plant, had been coated underneath with a two-coat coal-tar primer-mastic coating system and had been in service only 3 years when replacement was necessary. Based on reroofing and coating costs and this former roof life, indications are that a 6-month extension, before replacement is necessary, will provide a payout for application of this coating. This time period will expire in September 1952.

Bottom Rivet Corrosion

Distillate rundown tanks, being grouped closely in areas where welding is not allowed due to the fire and explosion hazard, although sandblasting is allowed under certain restrictions, are assembled at the site by cold riveting. Investigation of several cases of bottom leakage of such tanks revealed that leakage was occasioned by corrosion of the bottom rivets. Although this occurred prior to corrosion of the bottom plates to such an extent to make it necessary to install a reinforcing layer of tar paper-pitch-concrete, this reinforcement was done sooner than otherwise as the most practical method of sealing the rivet leaks.

In an experimental effort to retard bottom rivet corrosion, several systems of surface preparation and coating of a 1-ft.-wide strip along the bottom seams and rivet rows were tried in a new distillate rundown tank in February 1951. Methods of surface preparation included: (1) sandblasting only, (2) sandblasting and treatment with a weak phosphoric acid metal conditioner, (3) rotary wire brushing and wiping with solvent, and (4) rotary wire brushing, wiping with solvent, and treatment with a weak phosphoric acid metal conditioner.

Coatings employed consisted of: (1) a five-coat vinyl system, and (2) a two-coat application of alkyd red lead primer, a chlorinated rubber barrier coat, and two finish coats of vinyl. No inspection of this tank bottom has been made to date, but inspection is contemplated in the near future. Cost of this method of protection of tank bottom rivets is roughly from one-fifth to one-sixth that of installation of a reinforcing concrete bottom.

In December 1951 the entire interior surfaces of a new 40-ft. diameter by 10-ft. high sour-gasoline distillate tank, with exception of the bottom plates but including the bottom rivet rows, were sandblasted, primed with an inhibitive chlorinated rubber primer, and coated with a three-coat application of a chlorinated rubber adhesive. Appearance of this finished coating job was very good. Its visually apparent qualities and the economics involved appear to offer promise in this phase of corrosion control although it is understood that raw materials for manufacture of the coating are presently in very short supply.

Application of a baked-on phenolic type of coating was made to the sandblasted interior of a 70-ft. long by 10-ft. diameter propane storage tank in which serious corrosion had occurred. Trial of an air-drying vinyl or other air drying types of coatings was eliminated due to their lack of resistance to steaming operations, commonly used in gas- freeing of pressure vessels prior to interior inspection.

The baked-on phenolic-type coating showed definite signs of failure after only 8 months of service and this failure was attributed to inability of the applicator to obtain a sufficiently high baking temperature in such a large vessel to completely polymerize the coating, although the vessel was completely insulated with glass wool for the heated-air baking operation. It is proposed to recoat this vessel with a baking type of phenolic with an attempt to obtain a higher polymerizing temperature, and, if this fails, the vessel will probably be strip-lined with a corrosion-resistant sheeting.

Corrosion of Insulated Vessel

Evidence of water seepage underneath the magnesia block insulation on a 22-ft. diameter Petreco electrical desalting sphere, operated in conjunction with a Houdry catalytic cracking unit, was discovered during shutdown inspection of this unit the first week in February 1951. Removal of a small section of the insulation from the lower portion revealed the presence of thick corrosion scale and deep pitting.

This sphere was erected in October 1947 on vertical steel-beam supports

which were covered with brick fireproofing. The steel surface of the sphere was given no surface preparation nor coating prior to covering with 1-in. thick, 85 per cent magnesia block insulation which was secured to the surface with tiewire and wire netting fastend to steel nuts welded edgewise to the steel plate. A heavy coat of bituminous mastic was troweled over the entire exterior of the insulation as an atmospheric moisture seal.

The sphere is located just north of a chlorine plant and nearby an open top tank in boiler feed-water service which receives steam condensate through an overhead line. Although water seepage from normal heavy rainfall into and under the insulation through minute openings in the moisture seal coating probably saturated the insulation and caused some corrosion, it is thought that the combination of this with the exposure to chemical fumes from the chlorine plant and to steam from the condensate tank at the normal desalter operating temperature of approximately 160 F. was responsible for such thick corrosion scale formation and deep pitting after only 3 years and 4 months since erection.

Insulation Removed

It was decided to strip off all of the insulation, wet sandblast to remove the hard scale, then dry sandblast, apply a protective paint coating system, and, if heat loss was not too great, operate the sphere without insulation.

After a clean, rust-free surface was obtained by both wet and dry sand blasting, a surface-wetting and pit-penetrating, oil-type inhibitive lead chromate priming paint was well brushed onto the surface. Priming paint was applied to most of the surface the same day dry sandblasting was accomplished. However, on some portions, due both to foggy weather or to rain having fallen after dry blasting and before priming, light rusting occurred, which surface was pretreated with a phosphoric acid type of metal conditioner for passivating this thin rust film prior to application of the priming coat of paint.

The primer coat was followed by spray application of one complete coat of lead-free synthetic (alkyd type) zinc chromate-iron oxide paint, one complete coat of lead-free synthetic (alkyd type) titanium pigmented paint tinted with lamp black to an aluminum gray color, and a complete finish coat of spare varnish type of aluminum paint.

This desalter was put back in operation the last week in February 1951 and to date has been operated without insulation. The paint system used has afforded good protection and presents a good appearance to date.

Had operation, subsequent to removal of the insulation and application of the paint system, proved too inefficient, spray application of a gilsonite-asphalt mastic coating containing ground cork as a final coat was considered as a possible solution for affording satisfactory insulation, with the inhibitive type of priming paint serving as a corrosion inhibitor in direct contact with the metal to counteract the effect of the minute quantities of moisure vapor that will inevitably penetrate any coating system.

As a result of this experience, closer attention is now being given to measures which should reduce the severity of this type of corrosion. Four new 40,000-bbl.-capacity self-refrigerating butane storage spheroids were originally scheduled to be insulated with foamglas block between two layers of gilsonite-asphalt mastic without benefit of a prior inhibitive primer coat application to the steel. As a measure for retarding development of corrosion underneath the insulation, these spheroids were sandblasted and given a prime coat of lead chromate priming paint.

Plastic-Lined Valves

Over the past several years, baked-phenolic-lined valves have been tested in various chemical and sour-oil service lines with sufficient success to economically justify reclamation of a large number of used valves through remachining, plug replacement, and lining with a baked phenolic coating.

This type of lining is not resistant to caustic attack but withstands contact with various acidic solutions and sour oils and in a number of installations, especially in sour-oil service, where replacement of unlined valves has been required due to leakage in only a few months, the baked phenolic lined valve has given leak-free service for several years. This lining work must be done by experienced specialists in this field, and care must be exercised both in making installations and in operation of the valves to prevent chipping of the plastic, in order to provide satisfactory service.

Piping

Rapid corrosion of overhead pipe conduit for electrical wiring has been experienced in the aluminum chloride manufacturing and treating operations units due to hydrochloric acid attack from these fumes in combination with the high moisture content of the Gulf Coast atmosphere.

Various types of paint-coating systems have been tested on this conduit with little success in affording lasting protection against this attack. These included vinyl, phenolic, chlorinated rubber, latex emulsion, alkyd, asphalt-gilsonite, coal tar, and oil paints, the most practical of which proved to be brush application of five or six coats of a low-cost coal-tar or asphalt with relatively frequent recoating. None of these coating systems afforded adequate protection for more than 3 or 4 months without recoating, although the best methods of surface preparation, including sandblasting, were employed.

In November 1949, new Sheraduct conduit was installed at the aluminum chloride treating unit. Several sections were wrapped with polyethylene tape while the majority were painted with a liquid coating system of the phenolic type. A few sections were coated with a liquid latex emulsion. The paint coatings showed signs of failure within 2 months while the tape has been unaffected to date and is still affording good protection after more than 2 years in service.

It is thought that the use of this tape is definitely the answer to this corrosion problem. Although the material cost per unit area is somewhat higher than many coatings, cost of application on piping is much lower than that for liquid coating systems and the total applied cost is well within reason for a highly chemical resistant coating. The tape is composed of a 7-mil-thick extruded polyethylene film with an adhesive backing of 2 mils thickness and is furnished in 100-ft. rolls of 1, 2, 4, or 6-in. widths.

Test applications of this polyethylene tape have also been made to both underground and overhead transfer lines exposed to chemical and high moisture conditions. Good protection has been afforded except where its limitations of low resistance to heat and abrasion have had effect. Thorough cleaning and application of an inhibitive primer coat of paint is advocated for steel pipe before wrapping with the tape.

Quite extensive application of the polyethylene as well as test applications of adhesive-backed vinyl tape have recently been made to electrical conduit at a new forced-draft cooling tower, which conduit is exposed to almost constant high moisture or fog conditions. Extensive application of the polyethylene tape has also been made recently on new conduit installed at one of the older forced-draft cooling towers that was renovated for operation after having been out of service for some time.

The 1 and 2-in. widths are most practical for wrapping ½, ¾, 1, and 2-in. lines, whereas the 4-in. width is more suitable for pipe of 3, 4, or 6-in. diameter and the 6-in. width is used for wrapping 6-in. and larger pipe. In wrapping, an overlap sufficient to provide an adequate seal should be allowed.

Aluminum Sheeting

During 1947, certain grades of corrugated aluminum alloy sheeting were offered as suitable construction material for industrial usage at prices

appearing attractive. It was decided to give this material a trial in the refinery as a possible advantageous substitute for galvanized steel and asbestos siding and during that year several new buildings were constructed incorporating this aluminum sheeting as siding and roofing material.

Although some precautions against creation of galvanic cell corrosion through contact of dissimilar metals were taken during construction, it later developed that these were not sufficient, and it was also learned that the sheeting itself was insufficiently resistant to withstand the atmospheric exposures in the plant without paint protection.

In 1949, approximately 2 years after completion of construction, detailed inspections revealed the need for replacement of some of the sheets near the ground where contact with oyster-shell dust and moisture had caused alkali disintegration. Other portions had become pitted from damp, salt atmosphere and probably acid-fume attack in combination with high-humidity conditions. Pitting was much more pronounced on the south and west sides which were least protected from direct exposure to salt-laden prevailing damp winds from the seawater fronts. Breaks in the paint film on structural steel supporting members had allowed direct contact between the aluminum and steel in some instances.

On one building, the sheets had been secured to wood structural members with steel nails having lead-covered heads. The lead covering on the heads of a number of these nails had become hammer loosened in construction and many had lost the lead sheathing, thereby allowing moisture to create galvanic cell corrosion which was rapidly eating away the aluminum around the nail. This condition was corrected by refastening the sheets with neoprene-washered aluminum nails and moisture-proofing both the actual and potential steel-nail galvanic corosion spots with plastic roofing putty prior to painting of the entire exterior surface of the building.

Further pitting of the aluminum sheeting was eliminated by protection with a suitable paint film, application of which was preceded in most cases by brush-application surface preparation treatment with a weak phosphoric acid metal conditioner, designed for affording a good bond of the paint to aluminum. Galvanic corrosion was arrested by application of an insulating type of barrier coating to exclude moisture contact between dissimilar metals.

Recent inspections of the structures protected by the foregoing methods for 2½ years, more than equal the time wherein serious corrosion had occurred previously, indicates that early replacement of this aluminum siding was eliminated to an economic advantage.

Possibly some grades of aluminum alloy sheeting would be sufficiently resistant to plant atmospheric corrosion to preclude the necessity for painting. However, adequate measures for prevention of galvanic corrosion due to contact of dissimilar metals in the presence of moisture would be necessary.

Magnolia Reduces Furnace Corrosion In Polyformer

(Continued from page 309)

temperature while the main body of the oil is below this temperature.

Tube measurements are made with mechanical calipers at the ends of the tubes except for those tubes thinning in the middle which are measured initially with electric calipers to indicate questionable sections. The questionable sections are then checked with the Penetron for actual wall thickness.

Alloys for Headers

Corrosion of the original 5 per cent Cr.-½ per cent Mo. headers in the heating sections, aggravated by the presence of high-alloy tubes, necessitated the use of still higher-alloy steel for these headers. Headers in the most corrosive range of the heaters were inspected, and where practicable, repaired and reused in the less corrosive sections of the furnaces.

All headers are of rolled-in-tube design with a tube stop to provide additional seal. These stops soon corroded away, although the header wall thickness was sufficient for further use. Repairs consisted of undercutting the old stop and part of the roll, building up the stop with type 310 stainless steel weld rod, stress relieving, and machining to original size.

The original header plugs in the heating sections also presented a maintenance problem. These plugs of 5 per cent Cr.-½ per cent Mo. steel were protected by a 20-gage, 18-8 type stainless-steel pan. These pans were a constant source of difficulties, cracking severely at the bend formed at the junction of the plug face and plug seat. Cracking was so severe in some cases that the complete face of the pan would crack off and be carried away by the oil stream. After several unsuccessful attempts to prevent pan failure through heat treatment and different methods of attaching the pans to the plugs, the pans were discarded completely. The plug face and seating surfaces were undercut as necessary, built up with type 310 stainless steel weld rod, stress relieved and machined to original dimensions as shown in Fig. 6.

BOOKS

THEORETICAL PETROLOGY. By Tom F. W. Barth. Published by John Wiley & Sons, Inc., 601 West 26th Street, New York 387 pp. $6.50.

In this volume the author gives the present status of our knowledge in all fields of petrology—covering igneous, sedimentary and metamorphic rocks. The book is an exact and comprehensive scientific study of the rock-making processes, and an interpretation and synthesis of the existing quantitative data—the field data from all over the world, experimental data from geophysical and geochemical laboratories, and the theoretical data of the research workers in geology, chemistry, and physics. From these data the author sketches the cyclic history of the rock masses of the earth's crust; their origin, evolution, transfiguration, destruction, and redevelopment

THE EFFECTS OF DRILING-MUD ADDITIVES ON OIL-WELL CEMENTS. A special bulletin of the American Petroleum Institute's Division of Production, 816 Rio Grande Building, Dallas. 40 pp. $1.

This is a special report of the Mid-Continent District Study Committee on Cementing Practices and Testing Oil-Well Cements. The report has 265 tables and charts, summarizing the data obtained from a series of cooperative tests conducted by the study committee to determine the effect of several drilling-mud treating chemicals on the thickening time and strength of three types of commercial cement commonly used in oil-well cementing operations. These tests revealed that many of the drilling-mud additives, notably the organic materials in relatively small quantities, have a marked effect on the properties of the cement.

THE HANDBOOK OF MEASUREMENT AND CONTROL. Edited by M. F. Behar. Published by Instruments Publishing Co., Inc., Pittsburgh. 291 pp. $4.

This book describes every class and type of measuring instrument, illustrating them diagrammatically, and explaining them adequately. It starts out by reviewing the growth of instrumentation since 1924, mapping the present scope in diagrams and words. In succession come (1) Measurables, Effects and Methods, (2) Static Measuring Properties and Special-Function Components, (3) The Response—Dynamic Properties of Systems and Components, and (4) Prime Relays (mechanical, pneumatic, steam, hydraulic, magnetic, electrical, electronic, photoelectric). Useful tables of instrument characteristics appear in all chapters.

PIPING DESIGN AND ENGINEERING. Published by Grinnell Co., Inc., Providence, R. I. 221 pp. $10.

The plan of this book has been to compile in a single publication engineering and technical information for use of engineers engaged in the design and application of pressure piping systems available only by consulting a number of sources. To this has been added material never before published. Chapter headings give some idea as the book's contents: Expansion and Stresses, Velocity and Pressure Drop, Heat Transfer, Pressure-Temperature Pipe Graphs, Piping Materials, Pipe Fabrication, Pipe Hangers and Supports—these are a few of the subjects discussed. The book is liberally illustrated by diagrams and tabular material.

ENERGY SOURCES—THE WEALTH OF THE WORLD. By Eugene Ayres and Charles A. Scarlott. Published by McGraw-Hill Book Co., 330 West Forty-second Street, New York. 344 pp. $5.

How long will existing fuel supplies last, and what can we do against the day when they are exhausted? Here is an analysis of this vital problem—a thorough census of our energy sources, past, present, and future—technically sound, yet at the same time making fascinating reading, particu-

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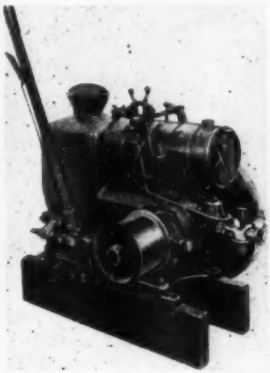

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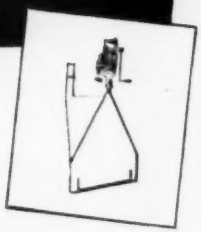

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Copper trays for a major chemical company are shown in this photo.

larly for all with any interest in science and technology. The history of man's efforts to wrest energy from nature is given, then a detailed review of the size of energy resources, technology of production, and progress being made in conservation. With only the statistics readily accessible elsewhere, the book interestingly tells much about all types of energy sources and what we may expect of them in the future. Oil, coal, hydroelectricity, even wind and tide power and others, are covered.

MODERN PYROMETRY. By Charles H. Campbell. Published by Chemical Publishing Co., 26 Court Street, Brooklyn. 150 pp. $4.

This little book describes the principles of and new developments in pyrometry. It also covers a well-selected group of pyrometric systems which will give a good over-all picture of the techniques used and equipment available for temperature measurement and control. Although the book has been written primarily for the metallurgist, all chemists, engineers, manufacturers, and technical workers who use high temperatures in their production work will find it useful. The book is illustrated with diagrams, halftones, and time-saving conversion tables.

MIDLAND COUNTY OIL. A development report on the oil fields of Midland County, Texas. Edited by Frank J. Gardner. Published by Petroleum News Corp., Box 331, Houston, 102 pp.

Here's a handy refrence book on one of the hottest counties in the hottest drilling area of the country. The center of the "spectacular Spraberry" trend is in Midland County and beneath this sprawling sand lens lie untold reserves in pre-Permian rocks. This book points out in its introductory remarks that only 3 years ago Midland County was producing only 600 bbl. of oil per day from four wells. Today there are some 750 oil wells in the county producing more than 100,000 bbl. daily. Details on the 15 fields with their 26 individual reservoirs that have accounted for this phenomenal rise in production are given in this book. Not only are all of the "vital statistics," including production by months by leases, given by reservoirs, but also significant sections of typical electric logs and contoured plats showing the location of all wells and leases.

Midland County Oil is the first in a series of small reference books on the oil and gas resources of the individual counties of Texas, New Mexico, and Louisiana, that Petroleum News Corp. proposes to publish.

THE ENGINEERS' ILLUSTRATED THESAURUS. By Herbert Herkimer. Published by Chemical Publishing Co., Inc., 212 Fifth Avenue, New York, 572 pp. $6.

Classified and arranged for quick and easy reference are more than 8,000 illustrations of mechanical movements, machine parts, and details. Every conceivable type of machine element is reproduced and identified. Where necessary an explanation of the method by which it accomplishes its particular function is given. Sketches of related parts are logically grouped for their suggestive value.

CORROSION TESTING. By Francis L. LaQue. Published by American Society for Testing Materials, 1916 Race Street, Philadelphia. 89 pp., $1.50.

The 1951 A.S.T.M. Edgar Marburg lecture, "Corrosion Testing," has been made available in this booklet. This informative lecture comprises a study of corrosion-testing programs and methods of corrosion testing, many of which have been sponsored by the A.S.T.M. Some of the topics discussed are: atmospheric corrosion studies, relations between rust color and corrosion; effects of alloying elements on the resistance of steels and irons to atmospheric corrosion; comparison of atmospheres, and galvanic corrosion.

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336 Refineries Now Operating, 32 Idle in U. S., Survey Shows

Total operating crude-oil input capacity exceeds 7,300,000 bbl. per day. Texas still in lead with more than 2,000,000 bbl. of daily capacity.

EXPLANATION OF ABBREVIATIONS USED IN TABLES

Refinery type:
- (S)—Crude-oil distillation
- (A)—Asphalt
- (L)—Lubricating oils
- (C)—Catalytic and/or thermal operations
- (W)—Wax
- (Comp.)—Complete refinery with S-C-L plus A and/or W.

Type of catalytic operations:
- (F)—Fluid
- (T)—Thermofor
- (H)—Houdry
- (Hf)—Houdriflow
- (Hy)—Hydroforming
- (Pf)—Platforming
- (C)—Cycloversion
- (S)—Suspensoid

Summary of Refineries in the United States

THEIR DISTRIBUTION AND CAPACITY*

	Operating plants				Idle plants			All plants		
	No. plants	Crude-oil cap.	Thermal operations cap.†	Catalytic operations cap.	No. plants	Crude-oil cap.	Cracking cap.	No. plants	Crude-oil cap.	Cracking cap.‡
Alabama	2	9,000						2	9,000	
Arkansas	6	64,500	22,800	21,000				6	64,500	43,800
California	46	1,093,300	367,350	237,000	9	91,500	5,000	55	1,184,800	609,350
Colorado	6	31,900	9,900	3,000				6	31,900	12,900
Delaware	1	3,500						1	3,500	
Georgia	1	5,800						1	5,800	
Idaho	1	3,500	600					1	3,500	600
Illinois	15	437,200	156,800	160,400	5	17,000	5,800	20	454,200	323,000
Indiana	9	403,950	113,100	112,750				9	403,950	225,850
Kansas	15	234,000	87,140	72,600	1	1,000	1,000	16	235,000	160,740
Kentucky	7	80,500	37,900	21,500				7	80,500	59,400
Louisiana	14	525,150	117,900	214,800	2	7,000		16	532,150	332,700
Maryland	3	68,500	13,000	27,000				3	68,500	40,000
Massachusetts	1	32,000	15,000					1	32,000	15,000
Michigan	16	151,900	27,800	39,720	1	3,500		17	155,400	67,520
Minnesota	2	7,000						2	7,000	
Mississippi	2	8,000	2,000					2	8,000	2,000
Missouri	1	39,000	18,500	20,000				1	39,000	38,500
Montana	10	60,000	15,000	18,300	2	1,800		12	61,800	33,300
Nebraska	4	10,900	1,300		1	300		5	11,200	1,300
New Jersey	7	446,000	86,600	168,000				7	446,000	254,600
New Mexico	8	20,050	7,400	6,000				8	20,050	13,400
New York	6	99,500	29,500	18,000				6	99,500	47,500
Ohio	12	306,600	143,600	127,500				12	306,600	271,100
Oklahoma	21	322,800	113,850	91,750	1	2,000		22	324,800	205,600
Oregon	1	6,000						1	6,000	
Pennsylvania	17	521,700	138,250	177,675				17	521,700	315,925
Rhode Island	3	13,000	1,400					3	13,000	1,400
South Carolina	1	7,500						1	7,500	
South Dakota	2	330			1	200		3	530	
Tennessee	2	7,000	1,200	2,600				2	7,000	3,800
Texas	65	2,088,345	664,620	579,800	8	11,150		73	2,099,495	1,244,420
Utah	5	67,750	10,500	24,000				5	67,750	34,500
Washington	3	13,500	1,000					3	13,500	1,000
West Virginia	3	12,500	6,250	1,500				3	12,500	7,750
Wisconsin	2	9,000	1,000					2	9,000	1,000
Wyoming	16	101,210	25,050	32,600	1	125		17	101,335	57,650
Total	336	7,312,385	2,236,310	2,177,495	32	135,575	11,800	368	7,447,960	4,425,605

*Capacities in barrels per day. †Includes thermal cracking, visbreaking, reforming, and various coking processes. ‡Includes both thermal and catalytic operations.

NORTH AMERICAN OPERATING REFINERIES

Where they are, their capacities, and types of processes

Compiled by The Oil and Gas Journal Statistical Department

ALABAMA

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
American Bitumuls & Asphalt Co.:			
Blakely (Mobile) (S-A)	6,000		
Hunt Oil Co.:			
Tuscaloosa (S-A)	3,000		
Total	9,000	None	None

ARKANSAS

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Berry Asphalt Co.:			
Stephens (S-A)	1,500		
Waterloo (S-L-A)	1,000		
Henry H. Cross Co.:			
Smackover (S.L.A.)	4,000		
Lion Oil Co.:			
El Dorado (Comp.)	22,000		T [1]6,000
MacMillan Petroleum Co.:			
Norphlet (S-L)	4,000		
Pan-Am Southern Corp.:			
El Dorado (S-C)	32,000	[2]22,800	F 15,000
Total	64,500	22,800	21,000

1. Polymer production capacity 400 bbl. daily.
2. Polymer production capacity 350 bbl. daily. Alkylate production capacity 1,500 bbl. daily.

CALIFORNIA

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Aromalene, Inc.:			
Long Beach (S)	1,800		
Bell Petroleum Co.:			
Casmalia (S-C)	3,500	200	
Calstate Refining Co.:			
Long Beach (C)		[12],500	
Caminol Co.:			
Hanford (S-C)	[6]6,800	[3]3,250	
Century Oil Co.:			
Signal Hill (S)	5,000		
Douglas Oil Co. of California:			
Bakersfield (S-C)	6,500	4,600	
Paramount (S-A)	4,000		
Economy Asphalt Co.:			
Oxnard (S-A)	2,000		
Edgington Oil Refinery:			
Long Beach (S-L-A)	5,000		
Envoy Petroleum Co.:			
Long Beach (S-A)	3,000		
Eureka Refining Corp.:			
Long Beach (S)	[4]4,500		
Five C Refining Co.:			
Santa Maria (S-A)	3,500		
Fletcher Oil Co.:			
Wilmington (C)		[5]3,600	
General Petroleum Corp.:			
Torrance (S-C	125,000	[6]22,500	T 48,000
Vernon (S-A)	4,000		
Golden Bear Oil Co.:			
Oildale (S-L-A)	3,000		
Hancock Oil Co. of California:			
Long Beach (S-C)	12,500	[7]7,000	
MacMillan Petroleum Corp.:			
Signal Hill (S)	7,000		
McCallen Refining Co.:			
Huntington Beach (S)	5,500		
Mohawk Petroleum Corp.:			
Bakersfield (S-C)	[8]11,000	[9]3,800	
Newhall Refining Co.:			
Newhall (S-A)	[10]3,500		
Norwalk Co.:			
Bakersfield (S-C)	10,000	3,000	
Oxnard Oil & Refining Co.:			
Oxnard (S-A)	2,500		
Palomar Oil & Refining Corp.:			
Bakersfield (S-L-A)	1,300		
Paraffin Companies, Inc.:			
Emeryville (S-A)	1,500		
Richfield Oil Corp.:			
Watson (S-C)	100,000	[11]45,000	T 23,000
Rothschild Oil Co. (Plant 1):			
Santa Fe Springs (S-C-A)	6,500	1,500	

CALIFORNIA (Continued)

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Seaside Oil Co.:			
Ventura (S-A)	4,000		
Shell Oil Co.:			
Martinez (Comp.)	45,000	26,000	
Wilmington (S-C)	52,000	[12]31,000	F 20,000
Socal Oil & Refining Co.:			
Huntington Beach (C)		1,800	
Standard Oil Co. of California:			
Bakersfield (S-C)	18,000	8,000	
El Segundo (S-C)	[13]127,000	[14]60,000	Pf [15]10,000
Richmond (Comp.)	138,000	[16]56,000	T 32,500
Sunland Refining Corp.:			
Bakersfield (S-C)	[17]6,000	[18]1,200	
Sunray Oil Corp.:			
Santa Maria (S-A)	7,500	3,000	
Sunset Oil Co.:			
Torrance (S-C)	[19]10,000	[20]2,500	
Texas Co.:			
Los Angeles (S-C)	60,000	[21]10,000	F 20,000
Tide Water Associated Oil Co.:			
Associated (Comp.)	[22]85,000	[23]34,100	F 22,500
Wilmington (S-C)	14,000	[24]8,200	
Triangle Oil & Refining Co.:			
Venice (S)	2,500		
Union Oil Co. of California:			
Bakersfield (S-A)	8,100		
Rodeo (Comp.)	[25]82,800	([26])	
Wilmington (S-C-A)	[27]71,000	[28]33,000	T; F [29]56,000
Western Asphalt & Refining Co.:			
Santa Maria (S-A)	1,500		
Wilshire Oil Co., Inc.:			
Norwalk (S-C)	22,000	[30]10,000	F 5,000
Total	1,093,300	367,350	237,000

1. Includes 500 bbl. daily capacity to be added during 1952.
2. Includes 1,800 bbl. daily of idle capacity.
3. Capacity includes: thermal cracking 1,000 bbl. daily operating and 450 bbl. daily idle; visbreaking 1,000 bbl. daily operating and 400 bbl. daily idle; reforming 400 bbl. daily operating.
4. Includes 2,500 bbl. daily idle capacity.
5. Polymer production capacity 50 bbl. daily.
6. Includes 16,000 bbl. daily visbreaking capacity.
7. Includes 5,000 bbl. daily visbreaking capacity.
8. Includes 3,500 bbl. daily idle capacity.
9. Polymer production capacity 60 bbl. daily.
10. Includes 500 bbl. daily idle capacity.
11. Alkylate production capacity 4,000 bbl. daily (800 bbl. daily capacity not operating). Propylene polymerization production capacity 350 bbl. daily.
12. Alkylate production capacity 5,000 bbl. daily.
13. Includes 10,000 bbl. daily idle capacity.
14. Alkylate production capacity 4,250 bbl. daily.
15. Under construction.
16. Alkylate production capacity 2,700 bbl. daily.
17. Includes 4,000 bbl. daily capacity under construction.
18. Under construction.
19. Includes 5,000 bbl. daily idle capacity.
20. Under construction and includes 300 bbl. daily polymer capacity.
21. Alkylate production capacity 3,800 bbl. daily.
22. Includes crude-oil charge capacity of visbreaking and feed preparation units.
23. Includes visbreaking facilities. Refinery equipped with alkylation facilities.
24. Visbreaking operation.
25. Includes throughput capacities of crude unit, asphalt unit, coker unit and crude-oil cracking operations.
26. Coking 20,000 bbl. daily and crude-oil cracking 24,000 bbl. daily included in crude-oil capacity of refinery. Polymerization facilities, 200 bbl. daily not operating.
27. Crude-oil capacity is divided, 61,000 bbl. daily to combination unit and 11,000 bbl. daily to topping unit.
28. Input capacity rating of combination unit. Alkylate production capacity 3,000 bbl. daily.
29. Fluid cat cracking unit of 28,500 bbl. daily capacity to be added in 1952.
30. Polymerization unit (600 bbl. daily capacity) not operating. Alkylation unit (2,000 bbl. daily) not operating. Isomerization unit (900 bbl. daily) not operating.

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COLORADO

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Bay Petroleum Corp.:			
Denver (S-C)	[1]11,000	[2]4,600	
Continental Oil Co.:			
Denver (S-C)	8,300	1,800	T [3]3,000
Empire Petroleum Co.:			
Denver (S-A)	[4]5,000		
Oriental Refining Co.:			
Alamosa (S-C)	1,100	900	
Denver (S-C)	5,000	2,000	
Skelly Oil Co.:			
Denver (S-C)	1,500	600	
Total	31,900	9,900	3,000

1. Includes 5,000 bbl. daily capacity to be added in 1952.
2. Polymer production capacity 200 bbl. daily. Thermal cracking capacity includes 1,000 bbl. daily operating and 1,000 bbl. idle reforming capacity.
3. Fresh-feed basis.
4. Includes 3,000 bbl. daily capacity to be added in 1952.

DELAWARE

Texas Co.:			
Claymont (S-A)	3,500		

GEORGIA

Mexican Pet. Corp. of Georgia:			
Savannah (S-A)	[1]5,800		

1. Includes 300 bbl. daily capacity to be added in 1952.

IDAHO

Phillips Petroleum Co.:			
Pocatello (S-C)	3,500	[1]600	

1. Cracked gasoline production capacity.

ILLINOIS

Advance Refining Co.:			
Centralia (S)	2,300		
Ashland Oil & Refining Co.:			
St. Elmo (S-C)	5,000	2,500	
Calumet Refining Co.:			
Burnham (S-L)	1,200		
Cross Co., Henry H.:			
Colmar (S)	200		
Globe Oil & Refining Co.:			
Lemont (S-C-A)	37,000	[1]21,500	F 6,000
Ohio Oil Co.:			
Robinson (S-C-A)	30,000	[2]9,000	F 12,400
Pana Refining Co. Div. of Illinois Farm Supply Co.:			
Pana (S-C)	4,400	[3]2,100	
Petco Corp.:			
Blue Island (S-C)	20,000	[4]7,500	Hf 7,500
Red River Refining Co.:			
Chicago (S-L)	1,100		
Shell Oil Co.:			
Wood River (Comp.)	120,000	[5]31,000	F 38,000
Sinclair Refining Co.:			
Hartford (S-C-A)	28,000	[6]13,000	F 10,000
Socony-Vacuum Oil Co., Inc.:			
East St. Louis (S-C)	30,000	13,200	H;T 18,000
Standard Oil Co. (Ind.):			
Wood River (Comp.)	46,000	[7]17,000	F 13,500
Texas Co.:			
Lawrenceville (Comp.)	47,000	[8]15,000	F 30,000
Lockport (S-C-A)	65,000	[9]25,000	F 25,000
Total	437,200	156,800	160,400

1. Includes 6,500 bbl. daily reforming capacity. Polymer production capacity 900 bbl. daily.
2. Polymer production capacity 1,000 bbl. daily.
3. Polymer production capacity 77 bbl. daily.
4. Includes reforming capacity of 1,500 bbl. daily and visbreaking capacity of 1,000 bbl. daily.
5. Includes reforming and visbreaking capacity. Refinery equipped with alkylation facilities.
6. Includes 6,000 bbl. daily reforming capacity. Polymer production capacity 600 bbl. daily.
7. Includes reforming capacity. Alkylate production capacity 2,500 bbl. daily. Polymer production capacity 50 bbl. daily.
8. Includes 5,000 bbl. daily reforming capacity. Polymer production 2,000 bbl. daily.
9. Alkylate production capacity 3,000 bbl. daily. Polymer production capacity 500 bbl. daily.

INDIANA

Cities Service Oil Co. (Del.):			
East Chicago (S-C)	35,000	[1]20,000	F 14,700
Indiana Farm Bureau Co-op Assn., Inc.:			
Mount Vernon (S-C)	10,000	[2]3,600	F 3,300
Johnson Oil Supply Corp.:			
Gary (S)	2,500		

INDIANA (Continued)

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
R. J. Oil & Refining Co., Inc.:			
Princeton (S)	[3]5,000	1,500	Pf [4]775
Rock Island Refining Corp.:			
Rock Island (S-C)	12,000		F [5]5,000
Sinclair Refining Co.:			
East Chicago (Comp.)	[6]105,000	[7]32,000	F 30,000
Socony-Vacuum Oil Co., Inc.:			
East Chicago (S-C)	25,000	[8]9,500	H 9,000
Standard Oil Co. (Ind.):			
Whiting (Comp.)	208,000	[9]46,500	F 50,000
Troy Refining Co.:			
Troy (S)	[10]1,450		
Total	403,950	113,100	112,750

1. Includes delayed coking capacity 17,500 bbl. daily and 2,500 bbl. daily reforming capacity. Alkylate production capacity 1,900 bbl. daily.
2. Polymer production capacity 300 bbl. daily.
3. Includes 2,000 bbl. daily of idle capacity and 1,500 bbl. daily capacity under construction.
4. Under construction.
5. Polymer production 300 bbl. daily.
6. Includes 15,000 bbl. daily to be added in 1952.
7. Includes 15,000 bbl. daily reforming capacity. Alkylate production capacity 650 bbl. daily. Polymer production capacity 2,450 bbl. daily.
8. Includes polyforming capacity.
9. Includes 5,000 bbl. daily reforming capacity and 11,200 bbl. daily reformer charge capacity. Alkylate production capacity 4,500 bbl. daily. Polymer production capacity 1,500 bbl. daily.
10. Includes 250 bbl. daily under construction.

KANSAS

Bareco Oil Co.:			
Wichita (S-C)	6,000	[1]5,800	
Bay Petroleum Corp.:			
McPherson (S-C)	6,000	[2]5,600	
Cooperative Refinery Assn.:			
Coffeyville (Comp.)	5,200	5,200	F 5,000
Phillipsburg (S-C)	4,200	2,100	
Derby Oil Co.:			
Wichita (S-C-A)	10,000	3,000	T [3]8,000
El Dorado Refining Co.:			
El Dorado (S-C)	9,500	4,800	F [4]4,600
Kanotex Refining Co.:			
Arkansas City (S-C-A)	[5]12,000	[6]9,300	F [4]4,600
Missouri Farmers Association:			
Chanute (S-C)	2,000	1,100	
National Co-op Refinery Assn.:			
McPherson (S-C)	23,000	[7]9,000	F [8]10,000
Phillips Oil Co.:			
Kansas City (Comp.)	60,000	(9)	F [10]15,000
Shallow Water Refining Co.:			
Scott County (S-C-A)	[11]4,000	[12]2,900	
Skelly Oil Co.:			
El Dorado (S-C-A)	40,000	[13]17,000	F 15,400
Socony-Vacuum Oil Co., Inc.:			
Augusta (S-C-A)	27,000	[14]8,940	T;H 10,000
Standard Oil Co. (Ind.):			
Neodesha (S-C)	19,700	[15]7,100	
Vickers Petroleum Co., Inc.:			
Potwin (S-C)	5,500	[15]4,400	
Total	234,000	87,140	72,600

1. Includes 2,500 bbl. daily reforming capacity. Polymer production capacity 250 bbl. daily.
2. Includes 1,000 bbl. daily operating and 1,000 bbl. daily shutdown capacities. Polymer production capacity 200 bbl. daily.
3. Includes 1,200 bbl. daily reforming capacity to be added in 1952.
4. Under construction.
5. Includes 2,500 bbl. of daily capacity to be added in 1952.
6. Includes 4,800 bbl. daily cat reforming capacity. Polymer capacity 550 bbl. daily.
7. Visbreaking capacity.
8. Polymer production capacity 800 bbl. daily.
9. Cracked gasoline production capacity from thermal and catalytic operations. Refinery equipped with alkylation and polymerization facilities.
10. Includes 1,500 bbl. daily capacity to be added in 1952.
11. Includes 1,000 bbl. operating plus 400 bbl. under construction of daily cat reforming capacity and 400 bbl. daily thermal cracking capacity under construction.
12. Includes 5,000 bbl. daily reforming capacity. Polymer production capacity 1,000 bbl. daily.
13. Includes visbreaking and reforming capacities. Refinery equipped with alkylation unit.
14. Includes 2,100 bbl. daily reforming capacity.
15. Includes 1,000 bbl. daily reforming capacity and 3,400 bbl. daily visbreaking capacity. Polymer production capacity 250 bbl. daily.

KENTUCKY

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Aetna Oil Co.:			
Louisville (S-C)	[1]11,000	6,600	
Ashland Oil & Refining Co.:			
Catlettsburg (1) (S-C-A)	18,000	[2]9,500	
Catlettsburg (2) (S-C)	25,000		T [3]18,500
Louisville Refining Co.:			
Louisville (S-C)	6,000	[4]3,300	F 3,000
Somerset Refinery:			
Somerset (S)	[5]2,000		
Standard Oil Co. (Ohio):			
Covington (S-C-A)	16,500	[6]18,500	
Stoll Oil Refining Co.:			
Louisville (S-L-W)	2,000		
Total	80,500	37,900	21,500

1. Includes 1,000 bbl. of capacity to be added in 1952.
2. Includes reforming capacity.
3. Refinery equipped with alkylation and polymerization facilities.
4. Includes reforming capacity. Refinery equipped with polymerization facilities.
5. Includes 500 bbl. daily of idle capacity.
6. Total charge basis (virgin plus recycle). Operations include reforming capacity. Polymer production capacity 400 bbl. daily.

LOUISIANA

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Bayou State Oil Corp.:			
Houston (S-L-A)	1,000		
Bay Petroleum Corp.:			
Chalmette (S-C)	16,000	[1]7,000	F 6,000
Calumet Refining Co.:			
Princeton (S-L-A)	700		
Canal Refining Co.:			
Church Point (S)	[2]1,700		
Cit-Con Oil Corp.:			
Lake Charles (L-W)	(3)		
Cities Service Refining Corp.:			
Lake Charles (S-C)	150,000	[4]10,000	F [5]85,000
Continental Oil Co.:			
Lake Charles (S-C)	11,000	[6]5,500	
Esso Standard Oil Co.:			
Baton Rouge (Comp.)	245,000	[7]50,000	F 105,000
Evangeline Refining Co., Inc.:			
Jennings (S-C)	1,250	300	
Gilcrease Oil Co.:			
Meraux (S)	5,000	[8]3,000	
Pan-Am Southern Corp.:		Hy; Pf	
Destrehan (S-L-A)	[9]30,000	[10]9,300	F [11]18,800
Petco Corp.:			
Marrero (S-C)	5,000	[12]4,000	
Shell Oil Co.:			
Norco (S-C-L)	50,000	[13]24,500	
Stanolind Oil & Gas Co.:			
Vivian (Superior) (S-C)	[14]8,500	[15]4,300	
Total	525,150	117,900	214,800

1. Polymer production capacity 600 bbl. daily.
2. Includes 500 bbl. daily to be added in 1952.
3. Processes stocks from outside sources to produce lubes and waxes. Throughput capacity 6,000 bbl. daily.
4. Total charge basis. Alkylate production capacity 7,500 bbl. daily.
5. Includes reforming capacity. Refinery equipped with polymerization and alkylation facilities.
6. Includes visbreaking and reforming. Facilities for polymer and alkylate production.
7. Visbreaking capacity to be added in 1952.
8. Includes 15,000 bbl. daily to be added in 1952.
9. Delayed coker, 9,300 bbl. daily, under construction.
10. Fluid cat cracker, 15,000 bbl. daily; hydroformer, 2,000 bbl. daily and Platformer 1,800 bbl. daily under construction. Alkylation unit, 2,500 bbl. daily, under construction.
11. Includes 1,000 bbl. daily reforming capacity.
12. Includes reforming capacity. Operations include alkylation and polymerization.
13. Includes 1,500 bbl. daily of shutdown capacity.
14. Includes 1,100 bbl. daily of reforming under construction. Polymer production capacity 190 bbl. daily.

MARYLAND

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
American Bitumuls & Asphalt Co.:			
Baltimore (S-A)	7,000		
Esso Standard Oil Co.:			
Baltimore (Comp.)	55,000	[1]13,000	F 27,000
Pan American Refining Corp.:			
Baltimore (S-A)	6,500		
Total	68,500	13,000	27,000

1. Includes reforming and visbreaking capacity. Refinery equipped with alkylation facilities.

MASSACHUSETTS

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Esso Standard Oil Co.:			
Everett (S-C-A)	32,000	15,000	

MICHIGAN

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Aurora Gasoline Co.:			
Detroit (S-C-A)	33,000	[1]10,500	Pf;F 13,500
Elsie (S)	5,700		
Bay Refining Corp.:			
Bay City (S)	10,500		
Crystal Refining Co. of Carson City, Inc.:			
Carson City (S)	6,200		
Lakeside Refining Co.:			
Kalamazoo (S)	2,300	[2]600	
Leonard Refineries, Inc.:			
Alma (S-C-A)	[3]18,000	[4]2,000	T [5]7,500
Marvel Refining Co.:			
Grand Rapids (S)	2,000		
Mid-West Refineries, Inc.:			
Alma (S-C)	10,000	[6]3,300	Pf 1,420
Naph-Sol Refining Co.:			
Muskegon (S-C)	5,500	2,500	
Old Dutch Refining Co.:			
Muskegon (S-C)	[7]12,500	1,200	Pf 2,500
Osceola Refining Co., Inc.:			
Reed City (S)	[8]2,000		
Petroleum Specialties, Inc.:			
Flat Rock (S-C)	6,500		Pf [9]1,000
Producers Refining, Inc.:			
West Branch (S-A)	[10]3,500		
Pure Oil Co.:			
Midland (S)	4,700		
Roosevelt Oil & Refining Corp.:			
Mount Pleasant (S-C)	7,500		C;Pf [11]4,800
Socony-Vacuum Oil Co., Inc.:			
Trenton (S-C)	22,000	[12]7,700	H 9,000
Total	151,900	27,800	39,720

1. Includes visbreaking capacity and 3,000 bbl. daily of idle reforming capacity. Polymer production capacity 500 bbl. daily.
2. Gasoline reforming capacity.
3. Includes net increase for 1952.
4. Idle capacity.
5. Includes 2,500 bbl. capacity to be added in 1952.
6. Includes cat reformer capacity. Polymer production capacity 70 bbl. daily.
7. Includes 8,000 bbl. capacity to be added in 1952.
8. Includes 800 bbl. of shutdown capacity.
9. Under construction.
10. Includes 1,000 bbl. of daily capacity shut down.
11. Platformer, 1,800 bbl. daily, under construction.
12. Includes polyformer capacity.

MINNESOTA

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Northwestern Refining Co.:			
New Brighton (S)	2,000		
St. Paul Park (S-A)	5,000		
Total	7,000	None	None

MISSISSIPPI

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Paluxy Asphalt Co.:			
Crupp (S-C-A)	3,500	2,000	
The Southland Co.:			
Sandersville (S-A)	4,500		
Total	8,000	2,000	None

MISSOURI

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Standard Oil Co. (Ind.):			
Sugar Creek (Comp.)	39,000	[1]18,500	F 20,000

1. Includes reforming capacity. Polymer production capacity 850 bbl. daily.

MONTANA

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Big West Oil Co. of Montana:			
Kevin (S-C-A)	2,000	[1]1,500	
Carter Oil Co.:			
Billings (S-C-A)	22,000		F 10,000
Continental Oil Co.:			
Billings (S-C)	6,800		F [2]3,300
Farmers Union Central Exchange, Inc.:			
Laurel (S-C-A)	[3]12,000	[4]6,000	F [5]5,000
Hart Refineries:			
Missoula (S-A)	800		
North Star Refining Co.:			
Shelby (S)	1,500		

MONTANA (Continued)

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Phillips Petroleum Co.:			
Great Falls (S-C)	2,800	[6]600	
Texas Co.:			
Sunburst (S-C)	7,500	5,000	
Union Oil Co. of California:			
Cut Bank (S-C)	3,600	[7]1,900	
Unity Petroleum Corp.:			
Kalispell (S.A.)	1,000		
Total	60,000	15,000	18,300

1. Includes 300 bbl. daily reforming capacity.
2. Polymer production capacity 360 bbl. daily.
3. Includes 2,000 bbl. daily capacity to be added in 1952.
4. Polymer production capacity 350 bbl. daily.
5. Under construction.
6. Cracked gasoline production including polymer.
7. Polymer production capacity 70 bbl. daily.

NEBRASKA

Cooperative Refinery Assn.:			
Scotts Bluff (S-C)	2,200	800	
Mid-States Refining Co.:			
Falls City (S)	6,000		
Searle Petroleum Co.:			
Omaha (S)	2,000	[1]500	
Sioux Oil Co.:			
Chadron	700		
Total	10,900	1,300	None

1. Visbreaking capacity.

NEW JERSEY

California Refining Co.:			
Perth Amboy (S-C-A)	60,000	[1]13,000	Hf [2]25,000
Cities Service Oil Co. (Pa.):			
Linden (S-A)	15,000		
Pettys Island (S-A)	[3]8,000		
Esso Standard Oil Co.:			
Linden, Bayonne, and Jersey City (Comp.)	165,000	[4]48,000	F 65,000
Socony-Vacuum Oil Co., Inc.:			
Paulsboro (Comp.)	[5]58,000	[6]9,200	H; T 22,000
Texas Co.:			
Westville (S-C)	60,000	[7]9,000	F 30,000
Tide Water Associated Oil Co.:			
Bayonne (Comp.)	80,000	[8]7,400	H; T 26,000
Total	446,000	86,600	168,000

1. Includes 3,000 bbl. daily visbreaking capacity under construction.
2. Alkylation production capacity 2,500 bbl. daily.
3. Capacity to be retired in 1952.
4. Includes visbreaking and reforming capacity. Alkylate production capacity 2,500 bbl. daily.
5. Includes crude oil charged directly to cracked units.
6. Includes reforming and visbreaking capacity. Alkylate production capacity 1,500 bbl. daily.
7. Reforming capacity. Polymer production capacity 2,500 bbl. daily.
8. Includes reforming capacity and 1,500 bbl. daily thermal cracking capacity on idle status. Polymer production capacity 3,500 bbl. daily.

NEW MEXICO

Arex Co.:			
Bloomfield (S)	200		
Continental Oil Co.:			
Artesia (S-C)	3,400	1,450	
Farmington (S)	750		
Famariss Oil & Refining Co.:			
Monument (S)	1,200		
Malco Refineries, Inc.:			
Roswell (S-C)	2,500	[1]1,750	
McNutt Oil & Refining Co., Inc.:			
Brickland (S-C)	3,000	[2]1,200	
New Mexico Asphalt & Refining Co.:			
Artesia (S-C)	7,500	[3]2,500	T 6,000
Petroleum Products Refining & Prod. Co.:			
Prewitt (S-C)	1,500	500	
Total	20,050	7,400	6,000

1. Includes 750 bbl. daily capacity to be added in 1952.
2. Polymer production capacity 35 bbl. daily under construction.
3. Idle capacity.
4. Polymer production capacity 250 bbl. daily.

NEW YORK

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Frontier Oil & Refining Co.:			
Tonawanda (S-C)	[1]20,000	[2]12,500	
Gulf Oil Corp.:			
Staten Island (S)	17,000		
Sinclair Refining Co.:			
Wellsville (Comp.)	9,000	8,000	
Socony-Vacuum Oil Co., Inc.:			
Brooklyn (Comp.)	[4]22,500	3,500	H 9,000
Buffalo (Comp.)	[5]24,000	5,500	H 9,000
Olean (S-L)	7,000		
Total	99,500	29,500	18,000

1. Includes 4,000 bbl. daily capacity to be added in 1952.
2. Reforming capacity including 10,000 bbl. daily capacity under construction.
3. Includes 2,000 bbl. daily reforming capacity.
4. Includes crude oil charged to cracking unit.
5. Includes idle capacity.

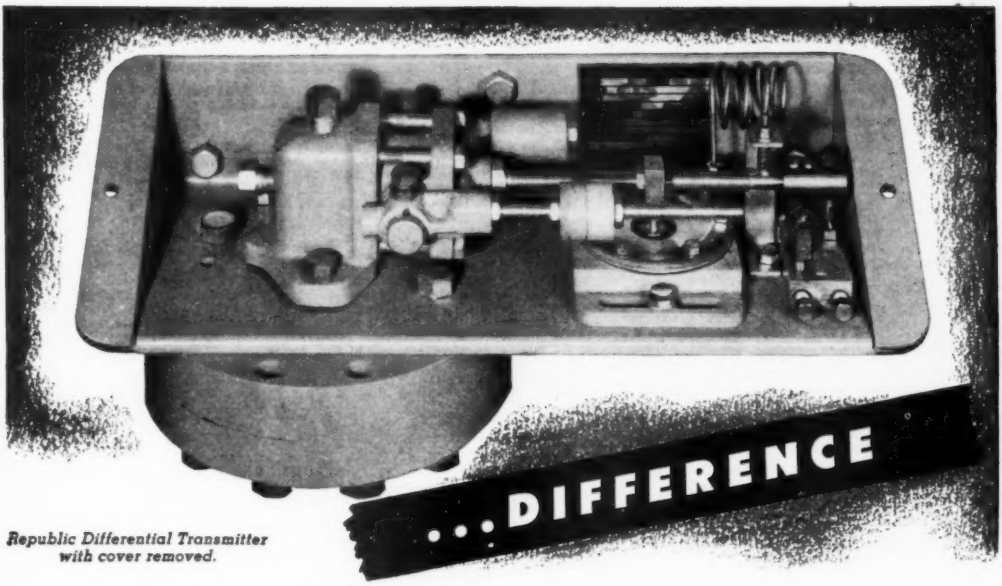
OHIO

Ashland Oil & Refining Co.:			
Canton (S-C)	12,000	3,000	
Deweese Oil Refinery:			
Weston (S-L-W)	500		
Gulf Refining Co.:			
Cleves (S-C)	30,000	[1]12,300	F 12,000
Toledo (S-C)	40,000	[1]12,200	F 12,000
National Refining Co.:			
Findlay (S-C)	9,500	[2]5,800	
Pure Oil Co.:			
Newark (S-C)	15,500	[3]9,000	F 4,500
Toledo (S-C)	29,400	[4]26,300	Hy 5,000
Standard Oil Co. (Ohio):			
Cleveland (Comp.)	42,500	[5]36,000	T [6]25,000
Lima (Comp.)	39,000	[5]27,000	F [7]27,000
Toledo (Comp.)	21,000	[8]31,000	
Sun Oil Co.:			
Toledo (S-C)	65,000	17,000	H; Hf 42,000
Western Reserve Refining Co.:			
Niles (S)	2,200		
Total	306,600	143,600	127,500

1. Polymer production capacity 1,500 bbl. daily.
2. Includes reforming capacity.
3. Includes reforming and visbreaking capacity. Polymer production capacity 200 bbl. daily.
4. Includes reforming, visbreaking and coking capacity.
5. Total charge basis. Thermal cracking capacity includes reforming operation. Polymer production capacity 700 bbl. daily.
6. Total charge basis. Thermal cracking capacity includes reforming and coking operations. Polymer production capacity 550 bbl. daily.
7. Includes 7,000 bbl. daily capacity to be added in 1952.
8. Total charge basis. Thermal cracking capacity includes reforming and coking operations. Refinery equipped with alkylation and polymerization facilities.

OKLAHOMA

Allied Materials Corp.:			
Stroud (S-A)	2,000		
Anderson-Prichard Oil Corp.:			
Cyril (S-C)	10,000	[1]5,000	
Bell Oil & Gas Co.:			
Granfield (S-C)	7,000	[2]3,750	Pf 1,500
Ben Franklin Refining Co.:			
Ardmore (S-C)	7,500	[3]4,500	
Champlin Refining Co.:			
Enid (Comp.)	20,000	[4]13,000	
Cities Service Oil Co. (Del.):			
Ponca City (Comp.)	20,000	[5]4,500	F 10,000
Continental Oil Co.:			
Ponca City (Comp.)	52,500	[6]12,500	T 16,750
Deep Rock Oil Corp.:			
Cushing (Comp.)	19,000	[7]6,200	F 6,200
Johnson Oil Refining Co.:			
Cleveland (S-C)	6,300	[8]2,750	Pf 1,800
Kerr-McGee Oil Industries, Inc.:			
Wynnewood (S-C)	[9]10,000	[8]4,000	
Mercury Oil Refining Co.:			
Oklahoma City (S-C)	5,000	1,500	
Mid-Continent Petroleum Corp.:			
West Tulsa (Comp.)	55,000	[11]18,000	F 17,500
Midland Cooperative Wholesale:			
Cushing (S-C)	6,500	[12]3,400	
Monarch Refineries, Inc.:			
Oklahoma City (S)	1,000		
Peppers Refining Co.:			
Oklahoma City (S-C)	1,500	[13]500	



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OKLAHOMA (Continued)

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Phillips Oil Co.:			
Okmulgee (S-C)	[1][2]12,000	([3])	F [3][4]2,500
Sunray Oil Corp.:			
Allen (S-C)	10,000	[5][6]8,000	
Duncan (S-C)	25,000	[7]5,000	F 15,000
Texas Co.:			
West Tulsa (S-C)	35,000	[8][9]14,000	F 15,000
Tide Water Associated Oil Co.:			
Drumright (S-C)	12,000	[10]5,000	Hf [10][11]4,000
Wilcox Oil Co.:			
Bristow (S-C)	5,500	2,250	Pf [12]1,500
Total	322,800	113,850	91,750

1. Polymer production capacity 150 bbl. daily.
2. Polymer production capacity 90 bbl. daily.
3. Polymer production capacity 100 bbl. daily.
4. Includes 4,000 bbl. daily reforming capacity.
5. Includes 2,700 bbl. daily reforming capacity.
6. Includes hydroforming capacity. Refinery equipped with polymerization and alkylation facilities.
7. Visbreaking capacity. Polymer production capacity of 50 bbl. daily.
8. Refinery equipped with polymerization facilities.
9. Visbreaking capacity including 2,000 bbl. daily of idle capacity.
10. Includes 1,000 bbl. daily of idle capacity.
11. Capacity includes reforming and visbreaking operations. Refinery equipped with polymer and alkylate production facilities.
12. Reforming capacity included.
13. Reforming capacity.
14. Includes 4,000 bbl. daily to be added in 1952.
15. Cracked gasoline production capacity from thermal and catalytic operations. Rating also includes 500 bbl. daily of production capacity to be added in 1952.
16. Plant equipped with polymerization facilities.
17. Visbreaking capacity. Refinery equipped with polymerization and alkylation facilities.
18. Includes reforming capacity. Polymer production capacity 1,500 bbl. daily.
19. Idle capacity.
20. Plant equipped with polymerization facilities.
21. Under construction.

OREGON

American Bitumuls & Asphalt Co.:			
Portland (S-A)	6,000		

PENNSYLVANIA

Atlantic Refining Co.:			
Philadelphia (Comp.)	117,000	[1]28,500	F 30,000
Cities Service Oil Co. (Pa.):			
Titusville (S-L-W)	3,000		
Freedom-Valvoline Oil Co.:			
Freedom (Comp.)	4,000	[2]1,750	
Gulf Oil Corp.:			
Neville Island (Pittsburgh) (S-C)	13,000	6,000	
Philadelphia (S-C-L)	107,000	[3]31,200	F 25,000
Kendall Refining Co.:			
Bradford (Comp.)	5,000	[4]2,200	Pf 1,360
Pennsylvania Refining Co.:			
Karns City (S-W-L)	1,400		
Pennzoil Co.:			
Rouseville (Comp.)	8,500	[5]5,850	Pf;F [6]5,025
Quaker State Oil Refining Corp.:			
Emlenton (Comp.)	2,000	1,350	
Farmers Valley (Comp.)	4,000	1,350	
Oil City (Comp.)	2,800	[6]1,230	F [7]1,070
Sinclair Refining Co.:			
Marcus Hook (S-C)	100,000	[8]32,000	F 30,000
Sonneborn, L., Sons, Inc.:			
Franklin (S-L)	2,000		
Petrolia (S-L-W)	4,000		
Sun Oil Co.:			
Marcus Hook (Comp.)	140,000	[9]24,000	H 84,500
United Refining Co.:			
Warren (Comp.)	5,000	[10]2,200	
Wolf's Head Oil Refining Co., Inc.:			
Reno (Comp.)	2,500	[7]620	F [7]720
Total	521,700	138,250	177,675

1. Includes reforming capacity. Refinery equipped with polymerization and alkylation facilities.
2. Includes reforming capacity. Polymer production capacity 50 bbl. daily.
3. Alkylate production capacity 2,400 bbl. daily.
4. Includes 700 bbl. daily of idle reforming capacity. Polymer production capacity 90 bbl. daily.

PENNSYLVANIA (Continued)

5. Portion of jointly owned facilities; a 2,200-bbl. daily Platformer is not included in this division of facilities. Polymer production capacity 280 bbl. daily.
6. Includes reforming capacity.
7. Portion of jointly owned facilities.
8. Includes 8,000 bbl. daily reforming capacity. Polymer production capacity 1,850 bbl. daily.
9. Reforming capacity.
10. Polymer production capacity 100 bbl. daily.

RHODE ISLAND

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
American Bitumuls & Asphalt Co.:			
East Providence (S-A)	1,500		
Socony-Vacuum Oil Co., Inc.:			
East Providence (S-C-A)	8,000	[1]1,400	
Texas Co.:			
Providence (S)	3,500		
Total	13,000	1,400	None

1. Idle capacity.

SOUTH CAROLINA

Esso Standard Oil Co.:			
Charleston (S-A)	7,500		

SOUTH DAKOTA

Hot Springs Refining Co.:			
Hot Springs (S)	200		
How Kola Refining Corp.:			
Sturgis (S)	130		
Total	330	None	None

TENNESSEE

Delta Refining Co.:			
Memphis (S-C)	[1]6,000	1,200	T [2]2,600
Southern Oil Service:			
Nashville (S)	1,000		
Total	7,000	1,200	2,600

1. Includes 2,000 bbl. daily capacity to be added in 1952.
2. Under construction.

TEXAS

American Liberty Oil Co.:			
Mount Pleasant (S-C-A)	14,000	[1]7,100	
Winnsboro (S-C)	3,300	[2]1,900	
Atlantic Refining Co.:			
Port Arthur (S-C)	55,000		F [3]26,000
Baird Refining Co.:			
Baird (S-C)	2,500	2,750	
Col-Tex Refining Co.:			
Colorado City (S-C-A)	8,745	[4]3,300	
Consumers Co-op Refinery Association:			
Levelland (S-C)	[5]5,000	2,600	
Continental Oil Co.:			
Wichita Falls (S-C)	7,000	[6]4,400	
Cosden Petroleum Corp.:			
Big Spring (S-C-A)	24,000	7,500	Pf;F [7]11,000
Crown Central Petroleum Corp.:			
Houston (S-C-L)	25,000	[8]9,200	T 17,500
Danaho Refining Co.:			
Pettus (S-C)	4,000	[9]1,500	
Eastern States Petroleum Co., Inc.:			
Houston (S-C)	48,000	[10]22,000	Pf;F[11]23,500
Eddy Refining Co.:			
Houston (S)	2,500		
Gladewater Refining Co.:			
Gladewater (S-C)	2,500	[12]750	
Great Southern Corp.:			
Corpus Christi (C)		4,000	
Gulf Oil Corp.:			
Fort Worth (S-C)	8,500	4,000	
Port Arthur (Comp.)	245,000	[13]84,200	H;T;F 94,000
Sweetwater (S-C)	8,000	4,000	
Humble Oil & Refining Co.:			
Baytown (Comp.)	[14]286,000	[15]79,000	F [16]101,000
Inland Refining Co., Inc.:			
Palestine (S-C)	2,000	[17]1,770	
Lacy, R., Inc.:			
Big Sandy (S-C-A)	3,000	1,000	
Magnolia Petroleum Co.:			
Beaumont (Comp.)	[18]175,000	[18]82,500	H;T 71,000
Fort Worth (S-C)	12,000	[19]7,300	
Maritime Oil Co.:			
Houston (S)	5,000		

TEXAS (Continued)

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
McBride Refining Co.:			
La Blanca (S-L-A)	2,500		
McMurrey Refining Co.:			
Tyler (S-C)	10,000	[2]8,200	
Mex-Tex Oil Co.:			
Rio Grande City (S)	200		
Monarch Refining Co.:			
San Antonio (S)	1,200		
Onyx Refining Co.:			
Abilene (S-C)	[3]6,000	[3] 5,500	
Pan American Refining Corp.:			
Texas City (S-C)	[4]130,000	[4]6,500	F 32,000
Panhandle Producing & Refining Co.:			
Wichita Falls (S-C)	[5]8,000	[5]1,750	F 1,500
Patton Oil Co.:			
Rotan (S)	1,500		
Peerless Tank Cleaning Co.:			
Kilgore (S)	1,000		
Petroleum Products Refining & Producing Co.:			
Leuders (S-C)	1,500	500	
Petrolite Corp.:			
Kilgore (S-W)	700		
Petrol Refining, Inc.:			
Texas City (S-C)	60,000		H 11,000
Phillips Oil Co.:			
Phillips (S-C)	70,000	[6]33,000	
Sweeny (S-C)	67,000	([6])	F [6]11,000
Pontiac Refining Corp.:			
Corpus Christi (S)	20,000		
Port Fuel Co.:			
Brownsville (S)	4,000		
Premier Petroleum Co.:			
Arp (S-C)	5,000	3,000	
Baird (S-C)	2,500	1,200	
Fort Worth (S-C)	4,500	1,600	
Longview (S-C)	4,000	1,600	
Pure Oil Co.:			
Nederland (Comp.)	55,000	[7]15,000	T 9,800
Rado Refining Co.:			
McAllen (S)	[8]2,750		
Republic Oil Refining Co.:			
Texas City (S-C)	40,000	[9]10,000	F 15,000
Shamrock Oil & Gas Corp.:			
Sunray (S-C)	10,000	[10]11,000	Hf [10]5,900
Shell Oil Co.:			
Deer Park (Houston) (Comp.)	115,000	[11]46,000	F 33,500
Sid Richardson Refining Co.:			
Texas City (S-C)	[12]25,000	[12]20,000	
Sinclair Refining Co.:			
Corpus Christi (S-C)	28,000	[13]10,000	H 12,000
Houston (Comp.)	90,000	[13]30,000	H;T 22,000
Skelly Oil Co.:			
Longview (S-C)	6,000	3,000	
Southwestern Oil & Refining Co.:			
Corpus Christi (S-C)	30,000	1,100	F [14]5,000
Standard Oil Co. of Texas:			
El Paso (S-C)	18,000	6,000	F [15]5,200
Taylor Refining Co.:			
Corpus Christi (S-C)	[16]47,000	[16]6,300	T [16]8,000
Port Isabel (S-C)	10,000		Pf 4,000
Texas Co.:			
Amarillo (S-C)	8,500	[17]4,000	
El Paso (S-C	5,500	3,000	
Port Arthur (Comp.)	200,000	[17]121,000	F 60,000
Port Neches (S-A)	40,000		
Three Rivers Refinery:			
Three Rivers (S-L-A)	1,500		
Tydal Co.:			
Gainesville (S)	1,800	400	
Ute Oil & Refining Co.:			
Graham (S)	650		
W. T. Waggoner Estate:			
Vernon (S-C)	5,000	2,500	
Wickett Refining Co.:			
Wickett (S-C)	3,000	[18]2,000	
Total	2,088,345	644,620	579,800

1. Includes 2,200 bbl. daily visbreaking and 900 bbl. daily reforming capacities. Polymer production capacity 225 bbl. daily.
2. Visbreaking capacity.
3. Polymer production capacity 100 bbl. daily.
4. Includes 3,000 bbl. daily reforming capacity. Polymer production capacity 60 bbl. daily.
5. Includes 1,000 bbl. daily idle capacity.
6. Includes reforming capacity. Polymer production capacity 650 bbl. daily.

TEXAS (Continued)

7. Includes 3,500 bbl. daily Platformer under construction. Polymer production capacity 600 bbl. daily.
8. Includes 1,200 bbl. daily reforming capacity.
9. Polymer production capacity 60 bbl. daily.
10. Includes 18,000 bbl. daily visbreaking capacity. Polymer production capacity 700 bbl. daily.
11. Includes 5,500 bbl. daily Platformer capacity under construction and 5,000 bbl. daily catalytic cracking capacity which is also under construction. Alkylate production capacity 2,200 bbl. daily.
12. Polymer production capacity 90 bbl. daily under construction.
13. Includes 17,000 bbl. of daily capacity on intermittent operation. Alkylate production capacity 4,000 bbl. daily. Polymer production capacity 500 bbl. daily not operating.
14. Includes 26,000 bbl. daily of idle capacity which requires major repairs before placing in operation.
15. Includes 8,500 bbl. daily reforming capacity and 33,000 bbl. daily idle thermal cracking capacity.
16. Ultimate capacity for 1952. Refinery equipped with alkylate production facilities.
17. Includes 750 bbl. daily reforming capacity. Polymer production capacity 100 bbl. daily.
18. Includes 25,000 bbl. daily capacity to be added in 1952.
19. Includes reforming 9,000 bbl. daily and visbreaking 48 000 bbl. daily capacities. Alkylate production capacity 4,500 bbl. daily. Polymer production capacity 800 bbl. daily.
20. Polymer production capacity 300 bbl. daily.
21. Includes visbreaking 6,000 bbl. daily and reforming 700 bbl. daily capacities. Polymer production 400 bbl. daily.
22. Includes 1,000 bbl. daily of idle capacity.
23. Includes reforming and 900 bbl. daily of shutdown capacity.
24. Capacity of topping and combination cracking units.
25. Catalytic reforming capacity. Thermal cracking operations carried out in combination unit. Alkylate production capacity 4,000 bbl. daily. Polymer production capacity 2,500 bbl. daily.
26. Current operating capacity of 5,200 bbl. daily will be replaced with new 8,000 bbl. per day unit during 1952.
27. Polymer production capacity 150 bbl. daily.
28. Cracked gasoline production. Alkylate production capacity 5,000 bbl. daily.
29. Cracked gasoline production from thermal and catalytic operations. Alkylate production capacity 2,500 bbl. daily.
30. Includes reforming and visbreaking capacities. Alkylate production capacity 2,000 bbl. daily. Polymer production capacity 800 bbl. daily.
31. Includes 750 bbl. per day of idle capacity.
32. Polymer production capacity 500 bbl. daily.
33. Includes 1,000 bbl. daily visbreaking capacity under construction and 5,000 bbl. daily of idle thermal cracking capacity.
34. Polymer production capacity 500 bbl. daily.
35. Includes reforming capacity. Alkylate production capacity 4,000 bbl. daily.
36. Includes 15,000 bbl. daily of idle capacity.
37. Total charge basis including reforming and visbreaking operations.
38. Includes 3,000 bbl. daily reforming capacity. Alkylate production capacity 1,700 bbl. daily.
39. Includes 12,000 bbl. daily reforming capacity. Alkylate production capacity 2,400 bbl. daily.
40. Under construction. Includes polymerization facilities.
41. Under construction. Alkylation facilities, 1,000 bbl. daily, under construction.
42. Includes 22,000 bbl. daily of idle capacity.
43. Includes reforming capacity and 4,000 bbl. daily of idle thermal cracking capacity.
44. Polymerization facilities.
45. Polymer production capacity 150 bbl. daily.
46. Includes reforming capacity. Polymer production capacity 3,000 bbl. daily. Alkylate production capacity 12,000 bbl. daily.
47. Includes reforming capacity.

UTAH

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Phillips Petroleum Co.:			
Woods Cross (S-C-A)	[1]10,000	[2]3,000	
Salt Lake Refining Co.:			
North Salt Lake (S-C)	27,000		Hf 10,000
Uinta Oil Refining Co.:			
Vernal (S-C)	1,250	300	
Utah Oil Refining Co.:			
Salt Lake City (S-C-L)	27,000	7,200	F [3]14,000
Western States Refining Co.:			
North Salt Lake (S)	3,500		
Total	67,750	10,500	24,000

1. Includes 5,800 bbl. daily to be added in 1952.
2. Cracked gasoline production capacity including 2,200 bbl. daily to be added in 1952.
3. Alkylate production capacity 3,800 bbl. daily; 2,200 bbl. daily capacity not operating.

WASHINGTON

Company, refinery location, and type—	Capacity, bbl. per day— Crude-oil charge	Thermal operations	Catalytic operations and type
American Bitumuls & Asphalt Co.:			
Richmond Beach (Seattle) (S-A)	4,500		
Phillips Petroleum Co.:			
Spokane (S-C)	5,000	[1]1,000	
Union Oil Co. of California:			
Edmonds (S-A)	4,000		
Total	13,500	1,000	None

1. Cracked gasoline production capacity.

WEST VIRGINIA

Elk Refining Co.:			
Falling Rock (Comp.)	4,500	[1]900	Pf [2]1,500
Pure Oil Co.:			
Cabin Creek (Comp.)	5,500	[3]4,000	
Quaker State Oil Refining Corp.:			
St. Marys (Comp.)	2,500	1,350	
Total	12,500	6,250	1,500

1. Polymer production capacity 100 bbl. daily.
2. Under construction.
3. Polymer production capacity 110 bbl. daily.

WISCONSIN

Lake Superior Refining Co.:			
Superior (S-C)	4,000	[1]1,000	
Wisconsin Oil Refining Co., Inc.:			
Sheboygan (S)	5,000		
Total	9,000	1,000	None

1. Includes reforming capacity.

WYOMING

C & H Refinery:			
Lusk (S)	160		
Continental Oil Co.:			
Glenrock (S-C)	3,400	[1]1,800	
Cooperative Refinery Association:			
Newcastle (S-C)	1,750	900	
Empire State Oil Co.:			
Thermopolis (S-A)	5,000		
Frontier Refining Co.:			
Cheyenne (S-C-A)	9,700	4,000	F [2]3,100
Husky Refining Co.:			
Cody (S-A)	5,000		
Ohio Oil Co.:			
Lovell (S-A)	6,000		
Pilot Oil Co.:			
Morton (S)	200		
Resolute Oil Corp.:			
Badger Basin (S)	1,000		
Sinclair Refining Co.:			
Sinclair (S-C-A)	25,000	[3]8,000	F 9,000
Sioux Oil Co.:			
Newcastle (S)	2,500		
Socony-Vacuum Oil Co., Inc.:			
Casper (S-C)	[4]8,500		T [5]6,500
Standard Oil Co. (Ind.):			
Casper (Comp.)	17,300	6,350	F 8,000
Texas Co.:			
Calpet (S)	500		
Casper (S-C-A)	15,000	[6]4,000	F 6,000
Wheatco Refining Co., Inc.:			
Wheatland (S)	200		
Total	101,210	25,050	32,600

1. Refinery equipped with polymerization facilities.
2. Polymer production capacity 250 bbl. daily.
3. Includes 2,000 bbl. daily reforming capacity. Alkylate production capacity 1,700 bbl. daily. Polymer production capacity 350 bbl. daily.
4. Includes 1,500 bbl. daily of idle capacity.
5. Refinery equipped with polymerization facilities.
6. Includes reforming capacity. Polymer production capacity 500 bbl. daily.

Shutdown Plants in the United States

CALIFORNIA

	Refinery type	Cap., bbl. per day— Crude oil	Cracking
Eagle Oil & Ref. Co., Santa Fe Springs	S-C-A	4,000	500
General Pet. Corp., Lebec	S	23,000	
Harbor Ref. Co., Long Beach	S	3,000	

CALIFORNIA (Continued)

	Refinery type	Cap., bbl. per day— Crude oil	Cracking
Maritime Pet. Corp., Wilmington	S	1,500	
Norwalk Co., The, Maricopa	S	10,000	
Olympic Refining Co., Long Beach	S	5,500	
Petrol Corp., Los Angeles	S	4,500	
Richfield Oil Corp., Vindale	S-C	10,000	4,500
Rothchild Oil Co., Santa Fe Springs	S	6,000	
Westoil Terminals Co., Wilmington	S	24,000	
Total		91,500	5,000

ILLINOIS

Arrow Petroleum Co., Centralia	S	4,500	1,800
Dupo Oil Refining Co., Dupo	S	1,000	
Harmony Oil Corp., Salem	S-C	4,000	2,000
Ashland Oil & Ref. Co., St. Elmo	S-C	5,000	2,000
Sol-Tex Ref. Co., Inc., Fairfield	S	2,500	
Total		17,000	5,800

KANSAS

Chanute Ref. Co., Chanute	S-C	1,000	1,000

LOUISIANA

Coast Oil Co., Cotton Valley	S	2,000	
Premier Oil Ref. Co. of Texas, Cotton Valley	S	5,000	
Total		7,000	None

MICHIGAN

Shamrock Oil & Ref. Co., Saginaw	S	3,500	

MONTANA

Hunt, Eugene, Winnett	S	300	
Solar Oil & Ref. Co., Hardin	S	1,500	
Total		1,800	None

NEBRASKA

Porter Oil Co., Sidney	S	300	

OKLAHOMA

Harper & Turner Oil Co., Edmond	S	2,000	

SOUTH DAKOTA

Rex Oil Refining Co., Rapid City	S	200	

TEXAS

Alba Refining Corp., Alba	S-A	1,500	
Bryson P. L. & Ref. Co., Bryson	S	1,200	
Dodds Ref. Co., Inc., Jacksonville	S	1,000	
Hamman Oil & Ref. Co., Bay City	S	2,000	
La Salle Pet. Corp., Burkburnett	S	1,500	
McBride, W. C., Inc., Bishop	S	3,000	
Muenster Ref. Co., Muenster	S	750	
Reischman, R. J., Fort Stockton	S	200	
Total		11,150	None

WYOMING

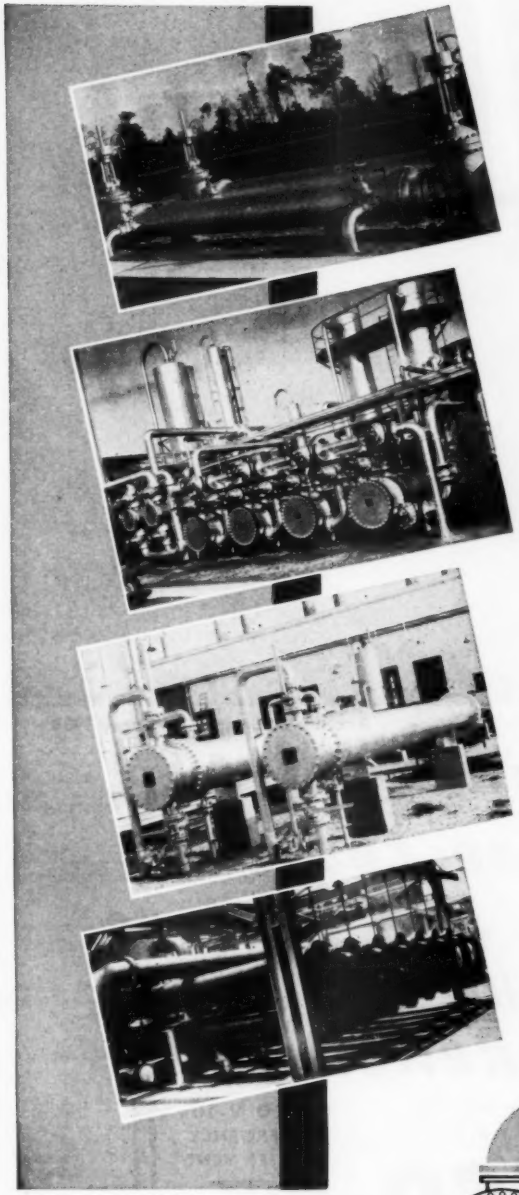
Crook County Refinery, Sundance	S	125	

Operating Plants in Canada

Summary of Refineries in Canada — Their Distribution and Capacity*

	No. plants	Crude-oil capacity	Cracking capacity†
Alberta	11	67,950	27,250
British Columbia	3	27,350	5,150
Manitoba	4	19,000	35,100
New Brunswick	1	300	
Northwest Territory	1	1,000	
Nova Scotia	1	22,000	9,900
Ontario	4	98,500	50,900
Quebec	4	160,000	104,700
Saskatchewan	8	46,250	25,600
Total	37	442,350	258,600

*Barrels per day basis. †Includes thermal reforming, cracking, visbreaking and similar operations plus catalytic operations.



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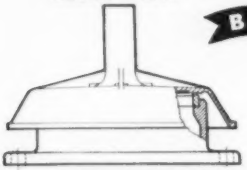

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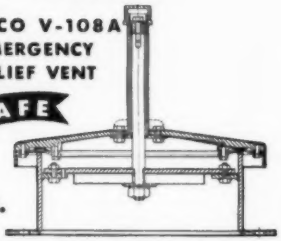

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ALBERTA

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
British American Oil Co., Ltd.:			
Calgary (S-C-A)	7,200	2,500	
Edmonton (S-C)	5,750	1,400	F 3,000
Excelsior Refineries, Ltd.:			
Lloydminster (S-C-A)	2,500		
Gas & Oil Refining, Ltd.:			
Hartell (S-C)	2,500	[1]2,300	
Husky Oil & Refining, Ltd.:			
Lloydminster (S-A)	7,500		
Lloydminster (S-A)	5,000		
Imperial Oil, Ltd.:			
Calgary (S-C-A)	16,000	[2]4,000	
Edmonton (S-C)	20,700	9,000	
McColl-Frontenac Oil Co.:			
Edmonton (S-C)	5,500	[3]2,200	F 2,600
Supreme Refineries, Ltd.:			
Ogden (S-C)	1,000	250	
Wainwright Refineries, Ltd.:			
Wainwright (S)	300		
Total	67,950	21,650	5,600

1. Includes 800 bbl. daily shutdown reforming capacity.
2. Refinery equipped with alkylation facilities.
3. Delayed coking capacity. Refinery equipped with alkylation facilities.

BRITISH COLUMBIA

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Imperial Oil, Ltd.:			
Ioco (Comp.)	12,000	2,750	
Shell Oil Co. of Canada, Ltd.:			
Burnaby (S-C-A)	7,000	[1]2,400	
Standard Oil Co. of British Columbia, Ltd.:			
Stanovan, North Burnaby (S)	8,350		
Total	27,350	5,150	None

1. Polymer production capacity 50 bbl. daily.

MANITOBA

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Anglo-Canadian Oils, Ltd.:			
Brandon (S-C)	3,000	[1]1,400	
Imperial Oil Co., Ltd.:			
Winnipeg (East St. Paul) (S-C)	10,800		F 3,100
North Star Oil, Ltd.:			
St. Boniface (S-C)	4,200	[2]1,800	
Radio Oil Refineries, Ltd.:			
East Kildonan (S)	1,000		
Total	19,000	32,000	3,100

1. Polymer production capacity 35 bbl. daily.
2. Includes 800 bbl. daily reforming capacity.

NEW BRUNSWICK

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
New Brunswick Oilfield, Ltd.:			
Weldon (S)	300		

NORTHWEST TERRITORY

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Imperial Oil, Ltd.:			
Fort Norman (S)	1,000		

NOVA SCOTIA

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Imperial Oil, Ltd.:			
Halifax (S-C-A)	22,000	9,900	

ONTARIO

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
British American Oil Co., Ltd.:			
Clarkson (Comp.	17,000	4,500	
Canadian Oil Refineries, Ltd.:			
Petrolia-Fromfield (S-C)	[1]20,000	2,900	Pf; F [2]14,000
Imperial Oil, Ltd.:			
Sarnia (Comp.)	55,500	3,000	S 23,000
Trinidad Leaseholds (Canada), Ltd.:			
Port Credit (S-C)	6,000	3,500	
Total	98,500	13,900	37,000

1. New refinery capacity to go on stream May 1952. Present Canadian Oil Co.'s plant, 4,000 bbl. daily, to be discontinued.
2. Platformer capacity 4,000 bbl. daily.

QUEBEC

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
British American Oil Co., Ltd.:			
Montreal East (S-C-A)	40,000	[1]7,500	16,900
Imperial Oil, Ltd.:			
Montreal East (S-C-A)	44,000	[2]11,300	F 12,000
McColl-Frontenac Oil Co., Ltd.:			
Montreal East (S-C)	43,000	[3]19,100	15,500

QUEBEC (Continued)

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Shell Oil Co. of Canada, Ltd.:			
Montreal East (S-C)	33,000	[4]9,900	12,500
Total	160,000	47,800	56,900

1. Refinery equipped with polymerization facilities.
2. Includes reforming and visbreaking capacities. Refinery equipped with polymerization facilities.
3. Includes reforming and visbreaking capacity. Polymer production capacity 1,500 bbl. daily.
4. Includes 1,100 bbl. daily under construction plus visbreaking and reforming capacities.

SASKATCHEWAN

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
British American Oil Co., Ltd.:			
Moose Jaw (S-C-A)	[1]15,000	[2]6,000	F 4,400
Hi-Way Refineries, Ltd.:			
Rosetown (S)	350		
Saskatoon (S-C-A)	2,800	800	
Imperial Oil, Ltd.:			
Regina (S-C-A)	20,000	[3]12,000	
Moose Jaw Refineries, Ltd.:			
Moose Jaw (S)	1,500		
Northern Petroleum Corp., Ltd.:			
Kamsack (S)	600		
Prince Albert Refineries, Ltd.:			
Prince Albert (S)	500		
Saskatchewan Federated Co-operative, Ltd.:			
Regina (S-C)	5,500	2,400	
Total	46,250	21,200	4,400

1. Includes 9,000 bbl. daily capacity to be added in 1952.
2. Includes coking unit capacity 2,500 bbl. daily and 1,500 bbl. daily thermal cracking under construction. Polymerization facilities, 500 bbl. daily under construction.
3. Includes reforming capacity. Refinery equipped with polymerization facilities.

Shutdown Plants in Canada

Company and refinery location—	Refinery type	Cap., bbl. per day: Crude oil	Cracking
Home Oil Distributors, Ltd., North Vancouver	S		
Hi-Way Refineries, Ltd., Moose Jaw, Sask.	S	350	
Lion Refining Co., Ltd., Calgary, Alta.	S	750	
Trump Oil Co., Morris, Man.	S	300	
Total		1,400	None

Operating Refineries in Mexico

Summary of Refineries in Mexico — Their Distribution and Capacity

	Operating plants: No. plants	Crude-oil capacity	Cracking capacity
Distrito Federal	**1**	**50,000**	**14,500**
Guanajuato	**1**	**30,000**	**4,500**
Tamaulipas	**3**	**101,000**	**6,000**
Veracruz	**3**	**43,000**	**6,000**
Total	**8**	**224,000**	**31,000**

Company, refinery location, and type—	Capacity, bbl. per day: Crude-oil charge	Thermal operations	Catalytic operations and type
Petroleos Mexicanos:			
Atzcapotzalco, D. F. (S-C)	50,000	[1]14,500	
Cuauhtemoc, Ver. (S-C)	15,000	6,000	
Madero, Tamp., C. Madero (Comp.)	75,000	6,000	
Madero, Tamp., Arbol Grande (S-A)	22,000		
Minatitlan, Ver. (S-L)	24,000		
Poza Rica, Ver. (S)	4,000		
Reynosa, Tamp. (S)	4,000		
Salamanca, Gto. (S-C-L)	30,000	4,500	
Total	224,000	31,000	

1. Refinery equipped with isomerization facilities. Alkylate production capacity 1,200 bbl. daily.

Refining Capacity in Nation Continues to Gain

Survey shows 30 major expansion projects, involving input capacity increases

by R. B. Tuttle

EXPANSION of the nation's crude-oil-refining capacity for the 1953-54 period is scheduled to run to a minimum of 400,000 bbl. daily. This increase is made up of additional capacity in existing refineries and entirely new plants. Some of the expansion projects involved in this capacity increase are just now getting under way, whereas others will not be started until later this year.

According to returns on The Oil and Gas Journal survey of currently active expansion projects, one new refinery is now being built, two others have been contracted, and a fourth new project is not yet contracted although its erection has been authorized. Five more new refinery projects are in various stages of planning. Of this group, two projects are well on the way toward authorization. Combined crude-oil input capacity of these eight projects is more than 170,000 bbl. per day.

More than 30 expansion projects involving crude-oil input-capacity increases were reported on via the Journal's current survey. Total capacity rating for all of these projects runs to more than 300,000 bbl. daily. However, the net increase is around 250,000 bbl. per day since a portion of this 300,000-bbl.-plus daily capacity is going into replacement of worn-out capacity.

This 1953-54 net gain in crude-oil capacity for the country's refining industry will bring total operating capacity to somewhere around 7,735,000 bbl. daily for the 1953-54 period. Total operating refining capacity for the United States this year runs to more than 7,312,000 bbl. daily. This capacity includes only operating refineries and any shutdown but operable capacity such refineries may have available, plus capacity which is to be added during 1952.

Approximately 25 projects incorporating catalytic cracking plants are included in the industry's 1953-54 expansion program. Capacity ratings on these projects total more than 280,000 bbl. daily. About half of these projects are under way with the remainder scheduled to start later this year.

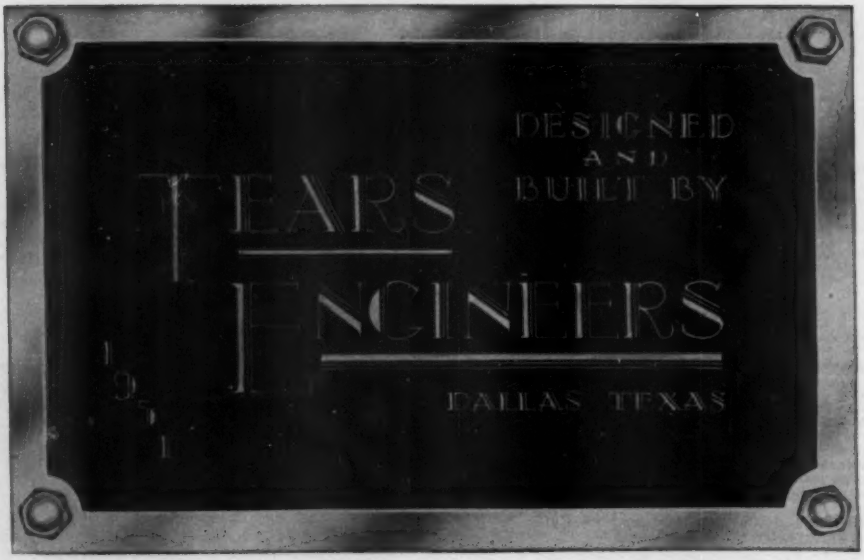
A number of other catalytic units will also be made available in 1953-54. These facilities principally comprise processes for upgrading naphthas and production of feed stocks for petrochemical operations. Nearly 45 per cent of these projects are yet to be started.

Active Refinery-Building Projects

Company, location, and type of project—	Capacity rating	Status	Comp. schedule	Contractors
Aetna Oil Co., Louisville:				
Refinery expansion		Building		
Alamo Chemical Co., Houston:				
Petrochemical plant		Planned		
American Liberty Oil Co., Mount Pleasant, Tex.:				
Cutback asphalt blender, bbl. per day	650	Building	Mid '52	
Cat. cracker, bbl. per day	5,000	Planned		
Ashland Oil & Refining Co., Buffalo:				
Plant expansion		Building		
Atlantic Refining Co., Port Arthur, Tex.:				
Expand chemical plant, lb. per day	180,000	Building	Late '52	E. B. Badger & Sons Co.; H. R. Ferguson
Atlantic Refining Co., Philadelphia:				
Cat. reformer, bbl. per day	10,000	Building	Early '53	E. B. Badger & Sons Co.
Expand asphalt plant, bbl. per day	325	Authorized	Early '53	
Crude unit, bbl. per day	45,000	Building	Mid '53	
Cat. Cracker, bbl. per day	30,000	Building	Mid '52	
Alkylation unit, bbl. per day	3,000	Building	Late '53	
Ammonia plant, tons per day	100	Planned	Mid '53	
Aurora Gasoline Co., Detroit:				
Increase cat. cracker, bbl. per day	2,000	Building	1953	
Increase gas-concentration plant				
B. A. Shawinigan, Ltd., Montreal, Que., Canada:				
Phenol plant, lb. per year	13,000,000	Building	Late '52	Canadian Kellogg Co., Ltd.
Bay Petroleum Corp., Denver:				
Cat. cracker, bbl. per day	3,600	Building	Early '53	Universal Oil Products Co.: Procon, Inc.
Feed-preparation unit			1953	
British American Oil Co., Ltd., Moose Jaw, Sask., Canada:				
Refinery expansion, bbl. per day	10,000	Building		
Cat. cracker, cat. poly, and coking units				
Gas-concentration plant and storage				
British American Oil Co., Ltd., Clarkson, Ont., Canada:				
Grease plant, lb. per year	15,000,000	Building	1952	
Caminol Co., Hanford, Calif.:				
Polymerization unit		Planned	1953	
Canadian Oil Companies, Ltd., Froomfield, Ont., Canada:				
New refinery, bbl. per day	20,000	Building	Early '52	Stone & Webster Engr. Corp.; Canadian Kellogg Co., Ltd.
Cat. cracker, bbl. per day	10,000	Building	Early '52	Universal Oil Products Co.
Platformer, bbl. per day	4,000	Building	Early '52	
Canal Refining Co., Church Point, La.:				
Boiler house		Building	1952	
Additional heat exchange		Building	1952	
Additional Water cooling		Building	1952	
Additional loading facilities		Building	1952	
Carter Oil Co., Salt Lake City:				
New refinery		Planned		
Carter Oil Co., Billings, Mont.:				
Poly plant, bbl. per day	500	Planned	1953	

Active Refinery-Building Projects (Continued)

Company, location, and type of project—	Capacity rating	Status	Comp. schedule	Contractors
Cities Service Oil Co. (Del.), East Chicago, Ind.:				
Refinery expansion		Planned		
Cities Service Oil Co. (Del.), Cicero, Ill.:				
Grease plant, lb. per year	8,375,000	Building	Mid '52	Sumner S. Sollitt Co.
Cities Service Oil Co. (Pa.), Linden, N. J.:				
Vacuum unit				
Cities Service Refining Corp., Lake Charles, La.:				
Hydroformer, bbl. per day	5,000			
Col-Tex Refining Co., Colorado City, Tex.:				
Cat. reformer			1953	
Continental Oil Co., Lake Charles, La.:				
Refinery expansion, bbl. per day	40,000	Building	Early '53	Stone & Webster Engr. Corp.; Badger Process Corp.
Platformer				Universal Oil Products Co.; Procon, Inc.
Cooperative Refinery Assn., Phillipsburg, Kans.:				
Increase crude unit, bbl. per day	4,000		Early '53	
Cat. cracking unit, bbl. per day	4,000		Early '53	
Poly unit			Early '53	
Gas-concentration unit			Early '53	
Cosden Petroleum Corp., Big Spring, Tex.:				
Platformer, bbl. per day	3,500	Building	Mid '52	Universal Oil Products Co.; Procon, Inc.
Udex unit		Building	Mid '52	
Deep Rock Oil Corp., Cushing, Okla.:				
Lube-oil blending and packaging plant		Building	Early '52	Chemical Plants, Div. of Blaw-Knox Const. Co.
Lube-oil solvent-refining plant, bbl. per day	1,075	Contracted	Early '53	M. W. Kellogg Co.; Refinery Engineering Co.
Delta Refining Co., Memphis:				
Cat. cracker, bbl. per day	3,000	Building		Koch Engineering Co.
Crude unit, bbl. per day	2,000	Building	Early '52	
Dominion Tar & Chemical Co., Ltd., Canada:				
Petrochemical plant, lb. per day	40,000			
Dow Chemical Co., Freeport, Tex.:				
Petrochemical plant				
Dow Chemical Co., Midland, Mich.:				
Toluene plant		Planned		Stone & Webster Engr. Corp.
Eastern States Petroleum Co., Inc., Houston:				
Platformer, bbl. per day	4,500	Building		
Increase cat. cracker				
Reactivate alky. unit				
Eldorado Refining Co., Eldorado,, Kans.:				
Refinery expansion, bbl. per day	6,000	Building		Refinery Engineering Co.
Elk Refining Co., Falling Rock, W. Va.:				
Platformer, bbl. per day	1,500	Building		Universal Oil Products Co.
Esso Standard Oil Co., Bayonne, N. J.:				
Atmospheric unit, bbl. per day	28,500	Building	Late '52	Lummus Co.
Esso Standard Oil Co., Everett, Mass.:				
Cat. cracker, bbl. per day	18,500	Building	1953	Foster Wheeler Corp.
Rerun still, bbl. per day	7,000	Building	1952	
Esso Standard Oil Co., Baton Rouge:				
Crude still, bbl. per day	60,000	Building	1953	M. W. Kellogg Co.
Expand cat. cracker		Building	1953	
Expand crude unit		Building	1953	
Esso Standard Oil Co., Baltimore:				
Crude desalter, bbl. per day	60,000	Building	Mid '52	M. W. Kellogg Co.
E. I. du Pont de Nemours & Co., Inc., Beaumont, Tex.:				
Petrochemical plant		Planned		
Farmers Union Central Exchange, Inc., Laurel, Mont.:				
Cat. cracker, bbl. per day	5,000	Building	Mid '52	Universal Oil Products Co.; Refinery Engineering Co.
Poly unit, bbl. per day	300	Building	Mid '52	Universal Oil Products Co.; Refinery Engineering Co.
Frontier Oil Refining Corp., Tonawanda, N. Y.:				
Cat. cracker				
Gas-concentration unit				
Additional polymer capacity				
Vacuum distillation unit				
Asphalt facilities				
Fulton & Olmstead, San Antonio:				
New refinery—				
Crude unit, bbl. per day	10,000	Authorized	1953	Koch Engineering Co.
Cat. cracker, bbl. per day	4,650	Authorized	1953	Universal Oil Products Co.
Platformer, bbl. per day	1,640	Authorized	1953	
General Petroleum Corp., Torrance, Calif.:				
Cat. cracker		Planned		
Gilcrease Oil Co., Meraux, La.:				
Cat. cracking unit, bbl. per day	3,000		1953	
Gilmore Refineries, Inc., Odessa, Tex.:				
New refinery, bbl. per day	50,000			
Great Northern Oil Co., St. Paul:				
Crude unit, bbl. per day	30,000			
Cat. cracker, bbl. per day	7,500			
Alky. unit, bbl. per day	2,500			
Cat. reformer, bbl. per day	6,000			
Cat. poly unit, bbl. per day	700			
Gulf Oil Corp., Philadelphia:				
Cat. cracker, bbl. per day	63,000	Contracted	Mid '53	M. W. Kellogg Co.
Distillation unit, bbl. per day	125,000	Contracted	Late '52	Foster Wheeler Corp.
Cat. reformer, bbl. per day	10,000	Planned	Mid '53	
Gasoline sweetening unit, bbl. per day	40,000	Building	Mid '53	



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Active Refinery-Building Projects (Continued)

Company, location, and type of project	Capacity rating	Status	Comp. schedule	Contractors
Gulf Oil Corp., Cincinnati:				
Packaging and blending plant		Planned	.....	
Gulf Oil Corp., Port Arthur, Tex.:				
Sulfur plant, tons per day	60	Contracted	Late '52	Ralph M. Parsons Co.
Isooctyl alcohol facilities		Building	Late '52	
Ethylene plant, tons per day	250	Building	Early '52	Lummus Co.
Sludge decomposition acid unit, bbl. per day	300	Planned	Late '52	
Heyden Chemical Corp., Houston:				
Methanol plant		Authorized	.....	.....
Imperial Oil, Ltd., Edmonton, Alta., Canada:				
Cat. cracker, bbl. per day	10,000	Building	Early '52	Foster Wheeler Corp.
Vacuum unit, bbl. per day	10,000	Building	Early '52	
Imperial Oil, Ltd., Sarnia, Ont., Canada:				
Refinery expansion, bbl. per day	15,000		.....	.....
Cat. cracker, bbl. per day	25,000	Contracted	.....	Canadian Kellogg Co., Ltd.
International Refineries, Inc., Wrenshall, Minn.:				
New refinery, bbl. per day	11,500	Building	Late '52	Lummus Co.
Cat. cracker				
Kanotex Refining Co., Arkansas City, Kans.:				
Vacuum unit, bbl. per day	5,750	Building	Late '52	Refinery Engineering Co.
Cat. cracker, bbl. per day	4,600	Building	Late '52	Refinery Engineering Co.
Kerr-McGee Oil Industries, Wynnewood, Okla.:				
Additions and modifications to plant			.....	.....
Koppers Co., Port Arthur, Tex.:				
Petrochemical plant		Building	.....	.....
Leonard Refineries, Inc., Alma, Mich.:				
Increase crude-oil cap., bbl. per day	10,000	Building	1952	
Additions to cat. cracker, bbl. per day	2,500	Building	1952	
Enlarge asphalt facilities, bbl. per day	700	Building	1953	
Increase L.P.G. capacity, bbl. per day	100	Building	1953	
McMurrey Refining Co., Tyler, Tex.:				
Cat. reformer, bbl. per day	5,000		1953	
Contact coker, bbl. per day	1,500		1953	
Magnolia Petroleum Co., Beaumont, Tex.:				
Feed-preparation unit		Building	Mid '52	
Mercury Oil Refining Co., Oklahoma City:				
Refinery expansion, bbl. per day	7,000	Building	Late '53	Refinery Engineering Co.
Cat. cracker				
Poly unit				
National Coop. Refinery Assn., McPherson, Kans.:				
Cat. cracker, bbl. per day	10,000	Building		Refinery Engineering Co.
Cat. poly unit, bbl. per day	600	Building		Refinery Engineering Co.
Increase crude unit, bbl. per day	3,000	Building		Refinery Engineering Co.
Revamp vacuum unit		Building		Refinery Engineering Co.
Revamp thermal cracker		Building		Refinery Engineering Co.
Northwestern Refining Co., St. Paul Park, Minn.:				
Cat. cracker, bbl. per day	7,500	Building	Late '52	Universal Oil Products Co.; Procon, Inc.
Ohio Oil Co., Robinson, Ill.:				
Coking unit, bbl. per day	6,000	Contracted		Lummus Co.
Alkylation unit, bbl. per day	1,500	Planned		.....
Cat. reformer, bbl. per day	7,000	Planned		
Old Dutch Refining Co., Muskegon, Mich.:				
Refinery increase, bbl. per day	7,500	Building	Early '52	Universal Oil Products Co.
Platformer increase, bbl. per day	1,200	Building	Early '52	Universal Oil Products Co.
Pan American Refining Corp., Texas City, Tex.:				
Cat. cracker, bbl. per day	30,000	Building	1953	Lummus Co.
Cat. poly unit, bbl. per day	800	Building	1953	Lummus Co.
Pan-Am Southern Corp., El Dorado, Ark.:				
Petrochemical plant, gal. per year	2,000,000	Contracted	Early '52	
Pan-Am Southern Corp., Destrehan, La.:				
Hydroformer, bbl. per day	2,000	Building		M. W. Kellogg Co.
Panhandle Producing & Refining Co., Wichita Falls, Tex.:				
Crude unit, bbl. per day	8,000	Building	Mid '52	
Petco Corp., Marrero, La.:				
Catalytic unit		Planned	.....	
Petroleum Specialties, Inc., Flat Rock, Mich.:				
Platformer, bbl. per day	900	Building	Early '52	Universal Oil Products Co.
Cat. cracker		Planned	.....	
Phillips Oil Co., Okmulgee, Okla.:				
Cat. cracker, bbl. per day	8,000	Building	Mid '52	Fluor Corp., Ltd.
Phillips Petroleum Co., Woods Cross, Utah:				
Cat. cracker, bbl. per day	8,000	Building	Late '52	Fluor Corp., Ltd.
Pure Oil Co., Smiths Bluff, Tex.:				
Cat. cracker		Contracted	Early '53	M. W. Kellogg Co.
Cat. poly unit		Contracted	Early '53	M. W. Kellogg Co.
Expand alky. unit		Contracted	Early '53	M. W. Kellogg Co.
Tube still		Contracted	Early '53	.....
Pure Oil Co., Toledo:				
Cat. cracker		Contracted	Early '53	M. W. Kellogg Co.
Cat. poly unit		Contracted	Early '53	M. W. Kellogg Co.
R. J. Oil & Refining Co., Inc., Princeton, Ind.:				
Platformer, bbl. per day	750	Building	Late '52	Universal Oil Products Co.
Republic Oil Refining Co., Texas City, Tex.:				
Platformer		Building	1953	Universal Oil Products Co.
Plant expansion		Building	1953	Universal Oil Products Co.
Richfield Oil Corp., Watson, Calif.:				
Cat. cracker		Planned		
Feed-preparation unit		Planned	.....	
Roosevelt O. & R. Corp., Mount Pleasant, Mich.:				
Platformer, bbl. per day	1,800	Building	Mid '52	Universal Oil Products Co.; Procon, Inc.

Active Refinery-Building Projects (Continued)

Company, location, and type of project	Capacity rating	Status	Comp. schedule	Contractors
Platreater, bbl. per day	450	Building	Mid '52	Universal Oil Products Co.; Procon, Inc.
Udex unit, bbl. per day	1,200	Building	Mid '52	Universal Oil Products Co.; Procon, Inc.
Salt Lake Refining Co., Salt Lake City:				
Vacuum unit, bbl. per day	9,500	Building		Bechtel Corp.
Shallow Water Refining Co., Shallow Water, Kans.:				
Increase capacity	1,500	Building	Early '52	
Residuum vacuum unit, bbl. per day	500	Building	Early '52	
Shamrock Oil & Gas Corp., Sunray, Tex.:				
Continuous contact coking unit, bbl. per day	1,000	Building	Mid '52	Lummus Co.
Shell Chemical Co., Houston:				
Ethyl chloride plant		Building		
Sulfur plant, tons per year	13,000	Building	Mid '52	Ralph M. Parsons Co.
Shell Chemical Co., Ventura, Calif.:				
Petrochemical plant, tons per day	150	Planned	Mid '53	
Shell Oil Co. of Canada, Ltd., Montreal, Que., Canada:				
Alcohol plant, tons per year	10,000	Building		C. F. Braun Co.
Shell Oil Co., Norco, La.:				
Refinery expansion, bbl. per day	25,000	Authorized		
Cat. cracker		Authorized		
Shell Oil Co., Wood River, Ill.:				
Expand refinery, bbl. per day	50,000			
Sinclair Refining Co., East Chicago, Ind.:				
Vacuum still, bbl. per day	20,000	Building	Mid '52	Arthur G. McKee Co.
Sinclair Refining Co., Wood River, Ill.:				
Sulfur dioxide treater, bbl. per day	10,000	Building	Late '52	Stone & Webster Engr. Corp.
Sinclair Refining Co., Marcus Hook, Pa.:				
Sulfur plant, tons per day	21	Building	Late '52	Ralph M. Parsons Co.
Sinclair Refining Co., Wellsville, N. Y.:				
Propane deasphalting unit		Planned		
Sinclair Refining Co., Houston:				
Cat. cracker, bbl. per day	50,000	Building	Late '53	C. F. Braun Co.
Topping unit, bbl. per day	35,000	Building	Late '53	Fluor Corp., Ltd.
Vacuum unit		Building	Late '53	
Sid Richardson Refining Co., Texas City, Tex.:				
Refinery modernization		Building	Early '52	
Skelly Oil Co., Longview, Tex.:				
Platformer, bbl. per day	1,500	Building	Early '52	Universal Oil Products Co.
Cat. poly unit		Building	Early '52	
Socony-Vacuum Oil Co., Inc.:				
Cat. cracker, bbl. per day	15,000	Building	1952	
Standard Oil Co. of California, El Segundo, Calif.:				
Platformer, bbl. per day	10,000	Building		Universal Oil Products Co.
Benzene facilities, bbl. per day	850	Building	Mid '52	Fluor Corp., Ltd.
Toluene facilities, bbl. per day	3,200	Building		Fluor Corp., Ltd.
Standard Oil Co. of California, Richmond, Calif.:				
Vacuum unit, bbl. per day	50,000			
Isobutane facilities				
Expand alkane facilities, bbl. per day	3,000	Contracted		Bechtel Corp.
Standard Oil Co. (Ind.), Sugar Creek, Mo.:				
Expand crude units, bbl. per day	30,000	Building	1952	Lummus Co.
Standard Oil Co. (Ind.), Whiting, Ind.:				
Benzene facilities, bbl. per day	1,070	Building	1952	
Sulfur plant, tons per day	30	Building	1952	Fluor Corp.
Standard Oil Co. (Ind.), Wood River, Ill.:				
Alcohol plant, lb. per year	10,000,000	Contracted	1952	M. W. Kellogg Co.
Standard Oil Co. (Ind.), North Dakota area:				
New refinery, bbl. per day	15,000	Planned		
Standard Oil Co. (Ohio), Cleveland:				
Crude units, bbl. per day	50,000	Building	Mid '52	Arthur G. McKee Co.
Standard Oil Co. (Ohio), Lima, Ohio:				
Expand cat. cracker, bbl. per day	27,000	Building	Mid '52	Arthur G. McKee Co.
Cat. reformer, bbl. per day	15,000	Contracted	Early '54	Lummus Co.
Revamp crude coker, bbl. per day	30,000	Contracted	Early '53	Lummus Co.
Standard Oil Co. (Ohio), Toledo:				
Alkylation unit, bbl. per day	3,000	Planned	1953	
Standard Oil Co. of Texas, El Paso, Tex.:				
Cat. unit, bbl. per day	10,400	Building	Mid '52	Catalytic Construction Co., Houdry Process Corp.; M. W. Kellogg Co.
Vacuum unit, bbl. per day	5,200	Building	Mid '52	
Alkylation unit, bbl. per day	940	Building	Mid '52	
Vapor-recovery plant		Building	Mid '52	
Stanolind Oil & Gas Co., Superior, La.:				
Hydroforming plant		Considered	1953	
Sun Oil Co., Marcus Hook, Pa.:				
Houdriformer, bbl. per day	11,000	Building	Late '52	
Sun Oil Co., Sarnia, Ont., Canada:				
New refinery, bbl. per day	15,000	Authorized		
Sunray Oil Corp., Corpus Christi, Tex.:				
New refinery, bbl. per day	25,000	Contracted	Late '53	Lummus Co.
Sunray Oil Corp., Duncan, Okla.:				
Rehabilitate alky. unit, bbl. per day	2,100	Contracted	Mid '52	Refinery Engineering Co.
Taylor Refining Co., Corpus Christi, Tex.:				
Aromatics facilities, bbl. per day	1,200	Planned		
Taylor Refining Co., Port Isabel, Tex.:				
Propane and L.P.G. recovery facilities, bbl. per day	600	Planned		
The Texas Co., Port Arthur, Tex.:				
Increase crude capacity, bbl. per day	20,000	Building	Early '52	
Increase steam facilities, lb. per hour	225,000	Building	Early '52	Foster Wheeler Corp.
The Texas Co., Westville, N. J.:				
Desalting unit, bbl. per day	60,000	Planned	Early '53	

Active Refinery-Building Projects (Continued)

Company, location, and type of project	Capacity rating	Status	Comp. schedule	Contractors
The Texas Co., Lockport, Ill.:				
Increase refinery capacity—				
Atmospheric-vacuum unit, bbl. per day	25,000	Planned	Early '54	
Furfural refining unit		Planned	Early '54	
Solvent-dewaxing unit		Planned	Early '54	
Contact filter plant		Planned	Early '54	
Propane deasphalting unit		Planned	Early '54	
Percolation filter unit		Planned	Early '54	
Compounding and packaging		Planned	Early '54	
The Texas Co., El Paso, Tex.:				
Crude oil unit, bbl. per day	4,000	Building	1953	
Cat. cracker, bbl. per day	5,000	Building	1953	
The Texas Co., Amarillo, Tex.:				
Crude-oil unit, bbl. per day	6,500	Building	1953	
Cat. cracker, bbl. per day	5,000	Building	1953	
Alkylation unit, bbl. per day	500	Building	1953	
Tide Water Associated Oil Co., Drumright, Okla.:				
Crude unit, bbl. per day	15,000	Contracted	Late '52	Born Engineering Co
Union Oil Co. of California, Wilmington, Calif.:				
Cat. cracker, bbl. per day	28,500	Building	Mid '52	Arthur G. McKee Co
Revision to cat. cracker				Arthur G. McKee Co
Crude units, bbl. per day	40,000	Building	Late '52	Fluor Corp.
Hydrogen sulfide-recovery system		Building	Mid '52	Girdler Corp.; Ralph M. Parson Co.
Addition to boiler plant and revision to steam system		Building	Late '52	C. C. Moore & Co.
Acid treater and rerun column, bbl. per day	15,000	Building	Late '52	C. F. Braun Co.
Revision to thermal cracker		Building	Mid '52	Fluor Corp., Ltd.
Additions and revisions to treating unit		Building	Mid '52	Ralph M. Parsons Co.
Sulfur plant, tons per day	50	Building	Late '52	Ralph M. Parsons Co.
Ammonium sulfate plant, tons per day	50	Building	Early '53	Ehrhart & Arthur
Union Oil Co. of California, Rodeo, Calif.:				
Modernize asphalt plant, tons per day	780	Building	Late '53	Ehrhart & Arthur
Utah Oil Refining Co., Salt Lake City:				
Increase boiler plant, lb. per hour	65,000	Building	Early '52	Stearns-Roger Mfg. Co.
Naphtha stabilizer, bbl. per day	8,000	Building	Early '52	
Vickers Petroleum Co., Inc., Potwin, Kans.:				
Increase refinery, bbl. per day	4,000	Building	1953	
Cat. cracker		Building	Mid '53	Southwest Engr. Co.
Wilcox Oil Co., Bristow, Okla.:				
Platformer, bbl. per day	1,500	Building	Mid '52	Universal Oil Products Co.; Procon, Inc.
Wood River Oil & Refining Co., Calumet City, Ill.:				
New refinery, bbl. per day	15,000			
Cat. cracker, bbl. per day	6,800			

For complete specifications write for Bulletin 50.

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The RS Standard Dead Weight Gage facilitates testing gas pressures; rock pressure at wells; static pressure on orifice meters and pipe line pressure in locating leaks. The design of the gage is based on the principle of applying pressure by a known weight to a hydraulic piston of known area; and of the converse effect to measure unknown pressure by balancing its force on a piston of known area with a known weight.

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READY TO GO.—The center section of pipe is on trucks on launching tracks. The sections on both sides were later moved to the tracks as pulling operations proceeded. Right, boom tractors handling heavy sections of coated pipe.

Tough River Crossing

Midwestern Constructors used 700-ft. launching track in crossing of Mississippi for Texas Illinois gas line

A LONG launching track extending 700 ft. on a 26° grade on the east bank of the Mississippi River was used by Midwestern Constructors, Inc., in the building of three 3,000 ft., 20-in. crossings in the Wittenberg, Mo.-Grand Tower, Ill., area.

The practice followed was to pull approximately 600 ft. at a time for the total of 3,000 ft. in each of the three river lines. Pipe was steadied on the bank by a guide-device utilizing war-surplus airplane wheels.

In the pulling of these crossings approximately 15 miles of Jones & Laughlin Steel Corp. wire rope was used, including 54,000 ft. by Midwestern and 25,000 ft. by McWilliams Dredging Co. Sections were pulled in the river by 1½-in. wire cable with breaking strength of 69 tons.

No clamps needed.—By using heavy laminated river pipe of 1⅛-in. wall thickness, weighing 200 lb. per lineal foot, the need for river clamps was eliminated.

This pipe was mill-fabricated by new processes of A. O. Smith Corp. by which ½-in. wall pipe was wrapped with two sheets of ⅜-in. plate. Altogether 31 beads were run in welding each joint in field operations on the river bank. Coating was protected against handling damage, by wooden slats.

In the period when the lines were pulled, river depth varied to the unusual extent of 29 ft. In September when the Mississippi River is ordinarily at its shallowest point in the year, the river was 22 ft. above normal.

Unique Line Crossing

Pipe helps support itself on bridge over washouts

AN unusual feature of a helium-gas line built for the U. S. Bureau of Mines is the type of bridge used to cross numerous gullies and washouts in New Mexico.

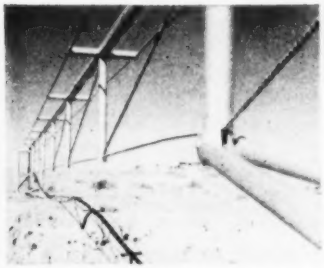
These bridges are unique because the pipe line itself supplies part of its own suspension support. This type of suspension could be termed a variation of a "bow string" bridge, but including some of the features of a cantilever bridge.

Piers are installed on each side of a wash, set back on solid ground far enough to prevent washouts and slides. They are made of 4-in. pipe set vertically and supplied with a horizontal member at the top, upon which the pipe line itself is laid. The bases of the piers are set in concrete.

The pipe line is not solidly attached to the top crossmember, but is free to move lengthwise on a channel-iron shoe welded to the lower side of the line to compensate for expansion and contraction of temperature.

Short stubs of 4-in. pipe are opposite each other at right angles to the line itself, and as the pipe line and

SPANS WASHOUT.—This helium pipe-line spans a washout in the New Mexico desert area by a crossing which is a combination "bow-string"-cantilever bridge. Line itself provides principal suspension.



CABLE. Piece of cable helps form bow-string bridge. Note intermediate piers welded to underside of pipe.

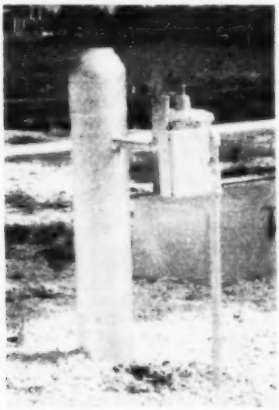
cross pieces lay flat on the ground, vertical posts are welded to the pipe line at the point of contact between the line and the right-angle studs.

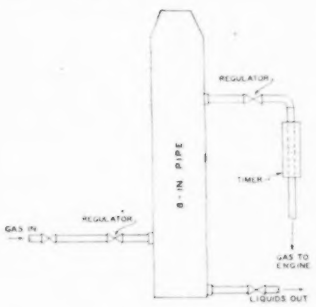
Outer ends of the stubs are notched to handle cable, which were pulled taut and welded in place. Purpose of this part of the design was to prevent side-sway during high wind storms.

Two lines.—There are two helium-gas lines in the area. One runs 90 miles from the Bureau of Mines Navajo helium plant at Shiprock, N. M., to the railroad at Gallup, N. M.; the second extends from the bureau's Excell, Tex., plant, 35 miles northwest of Amarillo, to the Amarillo helium plant.

Two-inch pipe was cased with 4-in. standard pipe, and the annular space filled with a thick cement slurry. This gives necessary strength to operate under the extremely high pressure of 2,800 psi. Cement slurry was mixed and pumped into the annular space with regular oil-well-cementing equipment.

Timer Shuts Off Fuel-Gas Supply to Stop Engine





"TIMER" — Left, photo; above, diagram.

Fuel for gas engines, where obtained from lease casing-head gathering systems, is usually passed through a "gas log" for removal of entrained liquids and for reduction of pressure before the fuel gas reaches the engine carburetor.

The accompanying photograph shows a gas-log installation which incorporates a fuel cutoff timer. This timer, located in the outlet line of the gas log, automatically shuts off the supply of fuel gas at a predetermined time to stop the engine. Assembly of the timer, pressure-reducing valves, and other parts of the gas log are shown in the sketch.

Variations of this gas log incorporate internal baffles where liquid entrainment is moderate. When casing head supplied to the gas log contains a high volume of entrained liquids, packing such as steel wool placed in the volume bottle aids stripping.

For normal conditions, accumulated liquid is manually drained out of the gas log. In cases where large volumes of separated liquids are involved, thus requiring frequent draining of the gas log, a bucket-type trap is installed to handle the job automatically.

This gas-log installation is on a Magnolia Petroleum Co. lease in Hurricane Creek field of South Louisiana.

Mud Pump on Skids, With Hose, Is Moved About Easily

Permanent skids for the mud pump, with hose connections attached, plus a boom on the rear to carry the suction pipe from the sump pit, has proved a time-saver for one of Gardner Brothers Drilling Co.'s rigs in the Fort Chadbourne field. (See photo.)

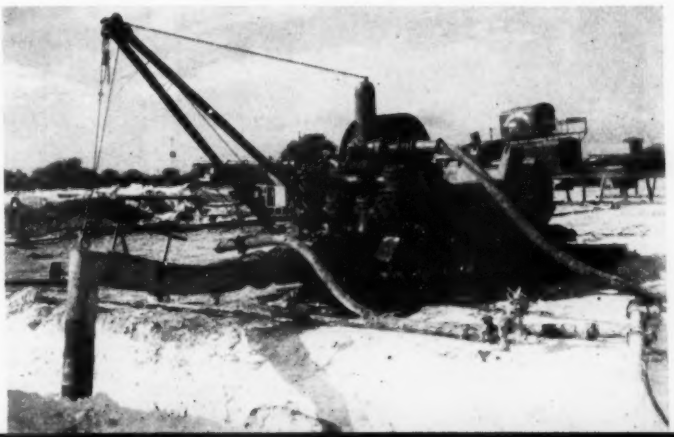
Figuring rig-time like money in the bank, this operator moves his rigs intact, with the exception of the mud pump, which is the only operating piece of equipment to be knocked down.

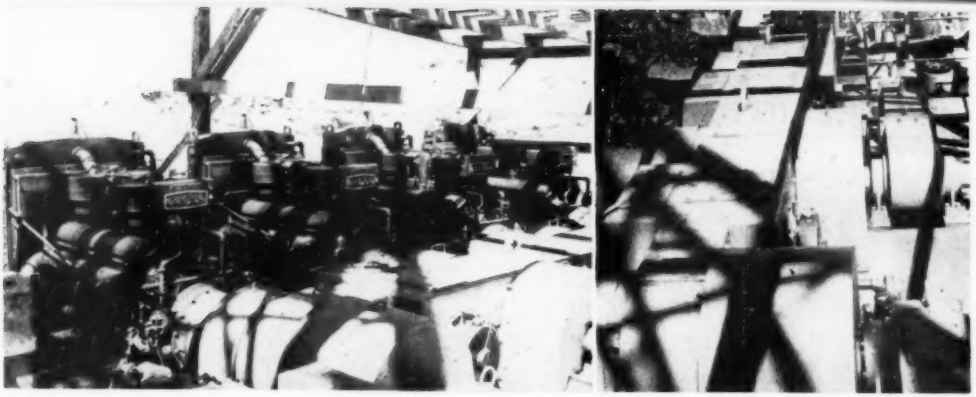
When a well is finished, connections are cut off from the rig's pump hose, the boom is raised with its own winch arrangement, (shown half way up on the A-frame) and the entire unit is hoisted aboard the rig-movers' truck for transporting to the next location.

At the new location, pits have been scooped out and water is waiting in the sump pit, ready to drill surface hole as soon as the rig has been set down in place. Steps necessary to put the pump into operation again after it has been set off at its prearranged spot, are:

1. When the derrick has been set down, connect hose lines on the rig; (2) attach the V-belts from the power on the derrick structure down to the pump drive-wheel; (3) lower the belt guard which is a hinged fixture attached to the derrick structure; (4) lower the boom on the sump hose and the mud pump is ready to go when the drilling engines are turning.

EASILY MOVED.—Mud pump, with suction hose, mounted on skids, is easily moved by Gardner Brothers Drilling Co.





Left: A partial view of the 12-cylinder, gas-gasoline-butane engines used on the converted power rig. Right: Four-engine drive or compound case.

Converting Steam Rig to Power

DRILLING POINTERS

A CONVENTIONAL steam rig was recently converted to a gas-engine-powered unit by Oil Well Supply Co. for Drilling & Exploration Co. The object was to utilize a steam draw works being used by Drilexco and still obtain the advantages of gas-engine power at a minimum cost. Converting the conventional steam rig to a gas-engine powered unit presented several interesting problems.

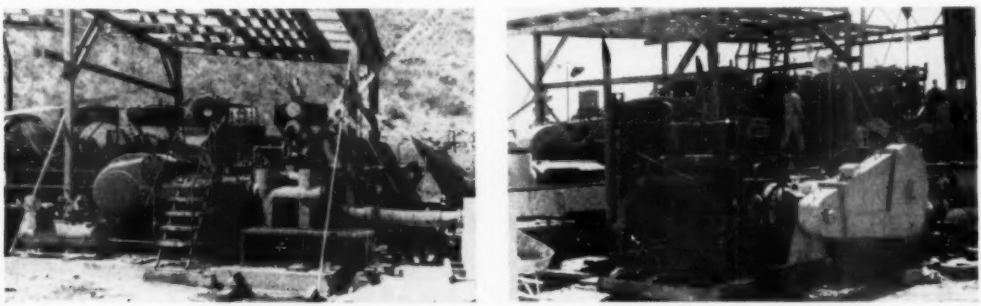
It was decided that the rig should be converted from conventional steam to gas-engine drive, if comparable flexibility could be obtained. The "basic floor plan" was laid out and turned over to the supply company. The aim was to create a string of drilling tools with all the advantages and none of the difficulties of steam power. The job was to build the new rig around the original draw works, the only piece of equipment selected from the original string of steam-powered tools.

Used in rough country.—This string had operated in the back country in mountainous areas for drilling depths below 13,000 ft. Where it had been operating, steam drilling in the area required a large number of packaged units for hauling, and the area was not plentifully supplied with water suitable for steam generation. Steep grades and many deep canyons were difficult to travel with heavy trucks, and the difficulties were multiplied when several loads were required to transfer tools from one location to another, perhaps a mile away on outpost drilling.

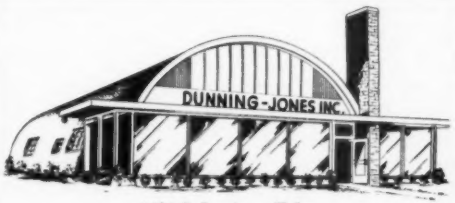
Digging qualities and mud-pump capacity, in addition to complete flexibility, were two of the most important points to be taken into consideration during the development of the rig. Hoisting up to 15,000 ft. of drill pipe with acceleration equal to steam was another point, and compact layout for speed of tearing down and rigging up were important features.

Rig requirements. — The contemplated rig should have a reserve of at least 1,400 hp. during the hoisting cycle which would be applied in such a manner that it would be flexible under maximum load conditions. It should accelerate the load rapidly because that can be obtained with a good steam rig. It should have an adequate range of speed to increase the number of pump strokes per minute without lugging or overloading the engines when extreme conditions are encountered. It should do all this without frequent changes of liners and plungers when ordinary power could not handle the circulation.

Use of torque converters.—To obtain power to drive the unit under all conditions, V-type, 12-cylinder, gas - gasoline - butane engines were selected. After all anticipated conditions were analyzed, there was only one method of applying the power and that was through torque converters. These converters would provide the engine flexibility essential to rapid acceleration; they would multiply the torque required for hoisting the drill pipe; and they would provide the varying speeds to meet pressure and volume demands of the mud pumps. The six engines selected have a combined horsepower of 2,550 at 1,800 r.p.m. These engines, set on individual bases with torque converters, are only about 8½ ft. long and weigh approximately 7,600 lb. each. The compactness of these engines and the low weight per horsepower enabled four of them to be mounted on one skid base in a package 8½ ft. wide and 29 ft. long, weighing approximately 21 tons. All of the air lines, fuel lines, and water lines were installed in the skid package so that only one connection for each of these



Mud and auxiliary requirements are handled by two 8 by 20-in. power pumps (left) and one 7¼ by 14-in. service pump (right).



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lines is necessary when rigging up. Mufflers and exhaust lines are also built into the subbase, or skid package.

The four-engine drive, or compound case, is a similar package approximately 8 ft. wide and 33½ ft. long. Both units are set on two substructures, each a package 35 ft. long, 8 ft. wide and 4 ft. high, so that a foundation 16 ft. wide is provided for mounting the engines, the four-engine drive, the torque converter, and the air clutches. These two substructures contain centering dowels for correct alignment when assembling the rig. The skid bases of the compound case and the skid base for the four engines are also doweled so that riggers cannot set the units except in correct alignment.

Rotary table direct-driven. — The drilling unit is run by a 12-cylinder engine mounted with table on a separate package for direct drive. This unit is also equipped with a torque-converter unit and a three-speed transmission case, two forward and one reverse. The table drive can also be operated from the draw works by disconnecting a chain-type flexible coupling and attaching a chain from the draw works to a sprocket on the table drive. Also, if disaster should strike the four engines or the four-engine compound while the pipe is in the hole, the pipe can be hoisted by the rotary table driving engine by connecting the chain to the sprocket on the engine side of the table and back again to the standard table drive on the draw works.

Clutches utilize converter creep.— Engaging and disengaging the jaw clutches is done by utilizing the creep of torque converters with the engines idling. A position was created on the driller's control lever labeled "creep." When placed in this position, a slow rotation of the drum clutches occur which facilitates engagement without releasing the master clutch. When the control is placed in the disengaged position, an air-cylinder booster disengages the clutches without undue shock. At the driller's position on the rig, the controls have been concentrated in one lever which provides an operating range for the air-actuated throttles, idling, creep, neutral, and neutral brake. One other lever actuates the forward and reverse in the transmision box on the four-engine drive, or compound.

Mud is circulated with two 8 by 20-in. power pumps through power takeoffs from the compound case which can be set for two engines to each pump or all four compounded on the two pumps. One of these pumps is located at the rear end of the four-engine drive and the other at the side of the compound transmission. Any range of speed can be placed on the pumps from an engine r.p.m. of idling to 1,800 r.p.m. if necessary so that the amount of mud and the pressure encountered can be taken care of without difficulty. A third pump is mounted as a package with a single-drive engine without torque converter so mud can be mixed by this 7¼ by 14-in. pump.

Unit packages. — For moving the rig over the rough mountainous country, the new rig was intentionally built in packages. Approximately nine packages contain the major units of the rig, all of which are within highway regulations as to clearance and weight. The rotary table and engine move as one package, the draw works as another, and the substructure for the draw works and the rotary table as another. The compound case with its skid base is a single package while the four engines form another.

The hoisting cycle is extremely fast. When going into the hole, the cycle has been timed at 50 seconds which is about as fast as men can attach elevators and set the slips. Rigging time is 6 hours.

Hot Water Deices Separators

PRODUCTION POINTERS

ICE formation in oil and gas separators has been solved in one San Joaquin Valley field of Central California by the use of hot water circulating through a shell around lead lines. This ice can form under peculiar circumstances of temperature and composition, in combination with gas and water vapors, when certain crudes tend to form hydrates, and plays havoc with liquid-level apparatus in the separator.

In the installation described here, the trunk lines leading from the various individual flowing lead lines from the various wells converge in parallel rows near the battery of separators which, in turn, are installed adjacent to the flow tanks and the vessels in the oil-treating equipment. To remedy the situation of icing, the first joint of pipe immediately upstream from the separators was removed from the trunk line and flanged fittings installed to replace similar pipe, which had been jacketed to form a single-tube, one-pass heat interchanger. The jackets, or shells, were insulated.

Each of the four parallel heating elements was provided with 1-in. pipe fittings at each end so that hot water might be circulated through the shell. These connections support risers which in turn were attached to a 2-in. horizontal header to which the supply and return line carrying the hot water might be fitted with ground joint lip unions. This oil contains formation water and is cut to an extent that heating is required to produce a standard grade of pipe-line oil. A gas-fired heater is employed to raise the temperature of the oil to the degree required for adequate treating and breaking the emulsion.

Water disposal.—Water in the base of the wash tank, free of oil, is disposed of by returning it to the formation. While this water is still hot, a small pump takes suction through a flanged tank fitting and suction line to force the hot water through the heating sections through which the fresh crude flows to the separators.

The header on the upstream end of the heating units supplies an outlet for the water, and a second pipe line returns it back to the wash tank. While atmospheric temperatures sometimes drop below 20° F., only a slight rise in the temperature of the fresh oil is required to prevent the formation of ice inside the separators.

Flow lines leading from field to separator battery carrying oil, containing small amounts of water and hydrates causing ice crystals, are provided with jackets into which hot water is circulated from wash tank to increase temperature above point of difficulty.

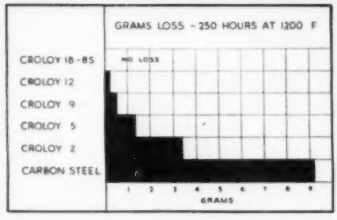
take a
CLOSER LOOK at

OXIDATION

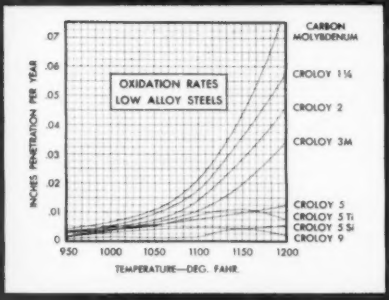
Oxidation is one of the simplest yet most frequently-encountered forms of corrosion affecting the service life of steel tubes in high-temperature applications. When tubes are exposed to elevated temperatures for extended periods of time, scale will form of sufficient thickness to flake off, causing progressive loss of metal. Resistance to oxidation, or scaling, is therfore an important consideration in determining the suitability of tubes for severe temperature conditions.

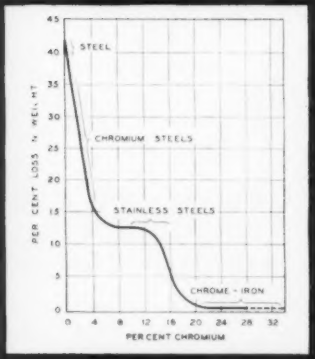
Chromium is the most effective alloying element for providing oxidation resistance in steel tubes. It forms a tight surface layer of chrome-rich oxide which retards inward oxygen diffusion and protects the underlying metal from attack. The amount of chromium required for utmost freedom from excessive scaling is generally in proportion to the temperature conditions to which the tubes will be subjected. Under certain conditions, additional oxidation resistance may be provided by adding small amounts of silicon, titanium, or aluminum.

Tubes of intermediate and stainless B&W CROLOYS are effectively meeting all requirements for oxidation resistance at elevated temperatures in petroleum and chemical processing equipment. Each of these Croloys will provide optimum service life within a definite range of operating conditions. Whenever you have a problem involving oxidation resistance, consult Mr. Tubes—your B&W Tube Representative, and get the benefit of the dependable technical service he represents.



COMPARATIVE OXIDATION RESISTANCE AT 1200 F





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PROGRESS in METALS

by W. L. Nelson
Consulting Engineer

Metal Sheet Joined By Stitching

IN joining relatively thin gages of metal sheet it has been found that metal stitching on a high-production basis is cheaper than riveting or welding. The bond obtained in this manner compares favorably in strength and durability with riveting or welding. Obviously, it can also be used to join metals to sheet of nonmetals such as felt, cork, asbestos, fiberboard, leather, sponge rubber, solid rubber, certain (noncracking) plastics, masonite, wood, and plywood.

Stitching is accomplished by cutting and forming a wire stitch and driving it through the pieces that are to be joined. The stitch is clinched on the far side as indicated in Fig. 1. The machinery employed in performing stitching is relatively simple and the bond formed is semipermanent in that the components may be disassembled without seriously damaging them. Dissembling is, of course, not a widely useful advantage.

Surprisingly thick sheets of metal can be stitched. Table 1 indicates various combinations of thicknesses and materials that may be stitched by "loop clinched" stitches. When using the "flat clinch" stitch somewhat thinner thicknesses are suggested for some operations. The very largest total thickness that may be handled (of metal and nonmetal) is $\frac{3}{4}$ in.

Metal stitching is used mainly for parts that are hidden or where a finished appearance is not significant. It has been used in the manufacture of automobiles (glove compartments, tacking strips of metal to steel, etc.), buses, trucks, refrigerators, space heaters, aircraft, metal furniture, garage doors, air-conditioning units, electric ranges, toys, and novelties. In certain favorable applications the saving by the use of metal stitching over the cost of conventional methods of attachment has been phenomenal, being 75 to even 90 per cent.

The first machine designed specifically for stitching was applied in 1938 by the automotive industry to the tacking of fiberwood strips directly to the steel body. All major automobile manufacturers use metal stitching machinery today and since 1943 the authorities of Wright Field have permitted the use of metal stitching in the manufacture of both secondary structural and nonstructural components of aircraft.

More detail is available in the paper by Arthur G. Denne "Metals and Nonmetals Joined Efficiently by Stitching," in the December 1951 issue of Materials and Methods.

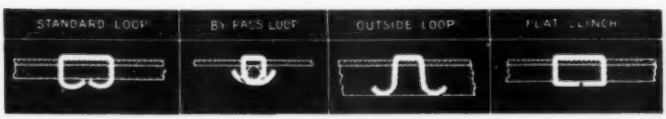


Fig. 1.—Four types of stitches are available. (Courtesy, Materials and Methods)

Automatic Metalizing Equipment

MACHINES are being developed for conducting the operation of metalizing in an automatic manner. One such machine is used to sandblast and metalize 2-in. scaffold pipe with a 0.004-in. layer of aluminum at a speed of 1,200 linear feet per hour. The machine is more than 40 ft. long and it can be effectively controlled or operated by only two men. The total cost for sandblasting and metalizing is less than 10 cents per square foot. This cost is less than 10 per cent of the cost of some nonautomatic metalizing jobs. Metallisation, Ltd., of Dudley, England, and its representative, Dix Engineering Co., Inc., of Lincoln Park, Detroit, are offering machines for specific production applications. The field of metalizing should be greatly enlarged by the application of automatic methods, particularly because the cost is extremely low.

Brazing Terms

Chemical Dip Brazing

A dip-brazing process wherein the filler metal is added to the joint before immersion in a bath of molten chemicals.

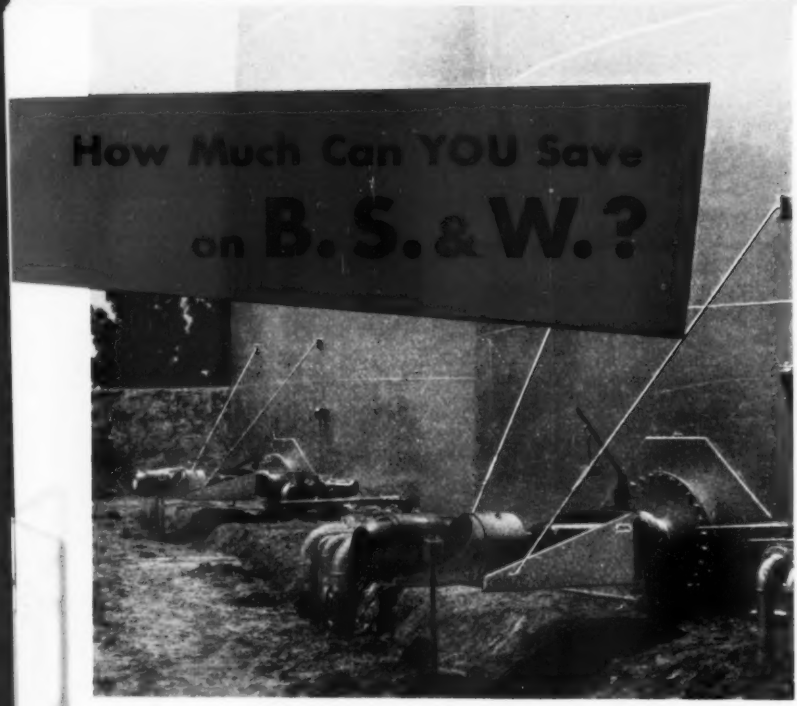
Metal-Dip Brazing

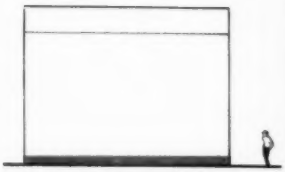
A dip-brazing process wherein the filler is obtained from a bath of molten metal.

TABLE 1—MAXIMUM THICKNESSES FOR STITCHING

	Recommended maximum stitchable material thicknesses (in inches) for loop-clinched metal stitches				
	Metal to metal any combination of these		Metal to metal any combination of these		Nonmetals
Aluminum (soft) 3SO, 52SO, 61SO, Alclad 24SO, R301-O, R301-W, 75SO, 75SW	0.093	0.093	0.125	$\frac{1}{8}$	Sheet cork
Aluminum ($\frac{1}{2}$ hard) 3S-H$\frac{1}{4}$, 52S-H$\frac{3}{4}$	0.064	0.064	0.080	$\frac{1}{16}$	Leather
Aluminum (hard) 61ST6, Alclad 24ST3, Alclad 24ST36, R301-T, 75ST6	0.040	0.040	0.064	$\frac{1}{16}$	Sheet asbestos
Aluminum extrusion	0.062	0.062	0.093	$\frac{1}{8}$	Fiberboard
1010 cold-rolled steel	0.0475 (18 ga.)	*0.0475 (18 ga.)	0.0800 (14 ga.)	$\frac{1}{8}$	Sponge rubber
Hot-rolled steel	0.0475 (18 ga.)	*0.0348 (20 ga.)	0.0625 (16 ga.)	$\frac{1}{16}$	Solid rubber
Galvanized sheet	0.0348 (20 ga.)	*0.0348 (20 ga.)	0.0475 (18 ga.)	$\frac{1}{16}$	Phenolics†
Stainless (Type 302) full hard	0.010	0.010	0.020	$\frac{1}{32}$	Plastics†
Stainless, $\frac{1}{2}$ hard	0.012	0.012	0.025	$\frac{3}{32}$	Standard masonite
Stainless, $\frac{1}{4}$ hard	0.015	0.015	0.030	$\frac{1}{16}$	Tempered masonite
Stainless, annealed	0.020	0.020	0.040	‡$\frac{3}{16}$	Solid wood
Sheet, brass, soft	0.030	0.030	0.050	‡$\frac{3}{16}$	Plywood
Sheet copper	0.035	0.035	0.064		

*Rockwell 50 on B scale, or softer. †Must be soft enough to penetrate without cracking. ‡Grain structure may cause leg wander in thicknesses over $\frac{3}{8}$ in.





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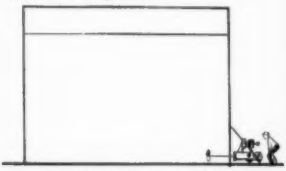

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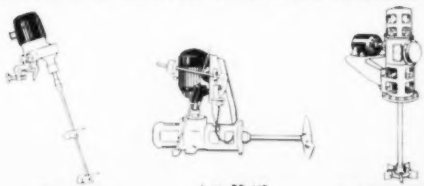

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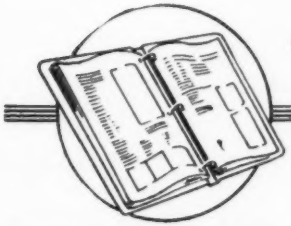

THE REFINER'S notebook

No. 114

Balanced Disk and Sealed Piston Relief Valves

by S. Chesler* and B. W. Jesser†

THE subject of relief valves was introduced in Refiner's Notebook No. 112 (March 3, 1952, page 95). Some definitions were given and the operation of forces within the conventional relief valve was discussed.

In No. 113 of this series possible application of "back pressure" relief valves was discussed. Capacity curves for the conventional type of valve and a good back-pressure valve were presented.

Vented bonnet.—First attempts to develop a back-pressure relief valve involved eliminating the vent between the bowl and the bonnet. The bonnet was then vented to atmosphere to release any vapors that leaked past the disk and the guide. With the bonnet under atmospheric pressure, forces D were eliminated (see Fig. 2a). This solved the situation to some degree when the valve was open and creating its own back pressure. However, when the valve was in the closed position with a superimposed back pressure at the valve outlet, forces C would act in conjunction with A against B and the disk would be lifted off the seat at vessel pressures well below set pressure.

Since that time the valve manufacturers in cooperation with some of the oil companies have been working on the development of a satisfactory back-pressure relief valve. Many types and designs have been tried out and tested but failed in one way or another to meet the desired requirements. However, developments have now reached the stage where installations of back pressure valves are being made in both isolated test installations and complete refinery installations.

Balanced disk and sealed piston. Back-pressure relief valves presently under consideration are in two general categories: (1) the balanced disk and piston valve, and (2) the bellows valve. One form of the balanced disk and piston group is illustrated in Fig. 1 and might be called the sealed piston type. It is a development from the vented bonnet valve in which a secondary piston has been added (assuming the disk itself is the primary piston).

The area of this secondary piston has been balanced against the seat area (i.e., the diameter of the secondary piston equals the diameter of the seat of the nozzle). A hole is located in the guide so as to permit the back pressure to be exerted both above and below the extended portions of the disk (or primary piston). The secondary piston makes a close fit with the guide so as to minimize leakage into the bonnet.

Thus, referring to Fig. 2b, the area over which the forces D are exerted is exactly equivalent to the area over which the forces C are exerted. Therefore, with vessel pressure below set pressure and a superimposed back pressure there should be no tendency for the valve to open before set pressure or be held closed after set pressure has been reached. Performance tests witnessed by the authors confirmed these conclusions. Blowdown was also satisfactory.

*Piping engineer, and †head of piping analytical section, M. W. Kellogg Co. Portion of paper presented at Toronto meeting of A.S.M.E.

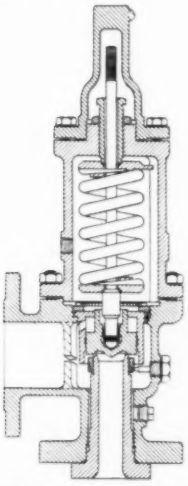

Fig. 1—Balanced disk and sealed piston relief valve. (Courtesy, Manning, Maxwell & Moore.)

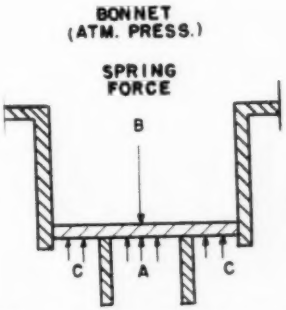

Fig. 2a — Conventional valve. (Vented bonnet.)

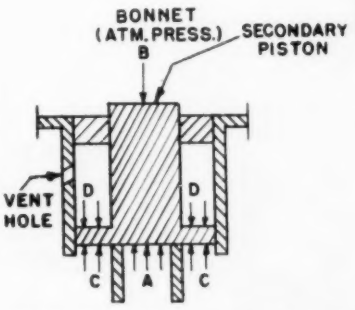

Fig. 2b—Balanced disk and sealed piston. (Vented bonnet.)

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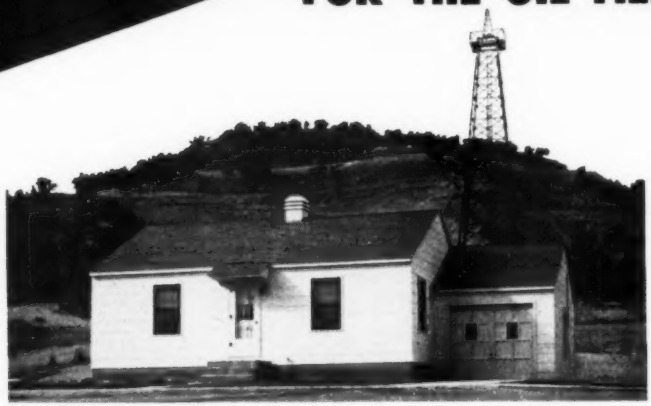

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Among the Drilling Contractors

Small Decline Shown in Number of Active Rigs

A sharp decline in the number of operating rotary rigs in the Kansas and Illinois basin areas during the week ended March 10 was offset to a large extent by substantial increases in drilling activity on the Gulf Coast and in the North and West Texas and New Mexico areas. Consequently, there was a decline of only six active rigs during the week in the overall total for the entire United States and western Canada regions. The sizable decreases in the Kansas and Illinois basin areas were attributed mainly to unfavorable weather conditions, many locations, particularly in the Illinois basin area being inaccessible because of boggy roads.

Active rigs in the United States and western Canada during the week totaled 2,839. The Rocky Mountain region, where much new exploratory work is in the making, was among the areas to show an increase in active rigs. The week's total was 565 greater than the number of rigs running at the same time a year ago.

ACTIVE ROTARY RIGS*
(United States and Western Canada)

Area—	Week ended 3-10-52	Change week ended 3-3-52	Change week ended 3-12-51
Gulf Coast	604	+ 20	+ 89
N. & W. Tex.-N. M.	1,027	+ 15	+ 244
Ark.-N. La.-E. Tex.	154	+ 2	+ 16
Oklahoma	311	0	+ 18
Kansas-S. Nebraska	130	—30	— 6
Illinois-Eastern	84	—13	+ 43
Rocky Mountains	164	+ 6	+ 51
Pacific Coast	168	— 2	+ 30
Total U. S.	2,662	— 2	+485
Western Canada	177	— 4	+ 80
Total	2,839	— 6	+565

*Courtesy Hughes Tool Co. Trends in drilling activity in the United States and the Gulf Coast and Arkansas-North Louisiana-East Texas areas are shown on pages 388 and 389.

Benton Ross is the contractor on a rank wildcat test which H. O. Pope and Rainey Oil Co. are starting at 1 Rushton, NW NW SE 6-5n-14w, 25 miles southeast of Hobart in eastern Kiowa County, southwestern Oklahoma.

Allied Supply Co., Shreveport, has two new contract jobs under way for Alcan Oil Co., also of Shreveport. Both are in Calhoun County, Arkansas. One is a wildcat test, 1 Calion, located a mile north of Lake Long and 3 miles southwest of the Hampton field, in the C SW NE 8-15s-14w. Contract is for 2,800 ft., which will provide a test of the Meakin sand, productive in the Hampton field. The other is a Meakin sand well, 4 Freeman Smith, in the Artesian field, with location in the S½ SE NE SE 17-15s-13w. Its objective is 2,580 ft.

Ray Holbert, Winnsboro, Tex., has a rig working on a wildcat location 4½ miles southeast of Caddo Mills, Hunt County, East Texas, where he is drilling for W. H. Bryant. The test is designated as 1 S. E. Chapman. Location is in the Jesse A. Asberry Survey.

L. B. Jackson Co., Tulsa, is using cable tools on a rank wildcat test it is drilling for Bergstrom-Butler Association in Conway County, in the north central part of Arkansas. Hole is projected to 3,500 ft. Location is on the operator's Sadler lease, 5½ miles southwest of Morrilton, in the SE SE NW 5-5n-17w.

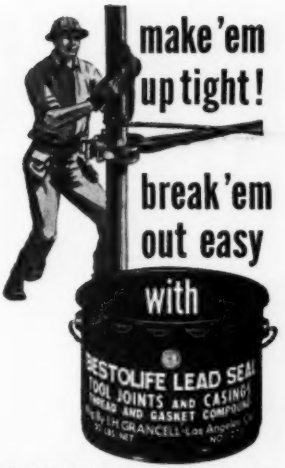
McAlester Fuel Co., Magnolia, Ark., is moving a rig to Ward County, North Dakota, where it will drill a deep wildcat test for Wannette Oil Co. at 1 Lee, C NE NE 24-156n-85w. Location is about 2 miles northwest of Minot.

S & S Drilling Co., Wichita, is the contractor on a rank wildcat test Bill Tomberlin is starting in southwestern Sheridan County, northwestern Nebraska. The test, designated as 1 Krause and located in the SE SE NW 3-26n-45w, will be carried to the granite, expected around 5,000 ft. Location is 3 miles northeast of Alliance.

Strain Drilling Co. has moved a string of rotary tools to a wildcat location in Decatur County, northern Kansas, where it will drill Harry Gore 1 Muirhead, NE NE SW 15-5-27.

Catline Dodson Drilling Co., Edmond, Okla., is drilling for Davidor & Davidor at a wildcat location 3 miles east of Marshall, Logan County, Oklahoma. Location is for 1 O'Neill, NW SW NE 12-19n-4w. Contract is for 5,000 ft. to carry the hole to the Layton sand.

Carmack Drilling Co., Denver, has a new deep wildcat test under way in Carbon County, Utah, where it is drilling for Equity Oil Co. It also is starting another well for Continental Oil Co. in the West Sussex area, Johnson County, Wyoming. The former test is 1 Mounds, located in the C SW NE 33-15s-12e. It is contracted to 8,000 ft. The latter, 7 Unit, NW



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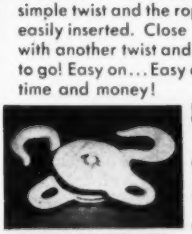

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SE NW 9-42n-79w, is an extension test.

Warren Burdett, Houston, is drilling for Hassie Hunt, trustee, at 1 Havena, 26-5s-9w, a projected 9,000-ft. wildcat test in Beauregard Parish, Louisiana Gulf Coast.

J. D. Sprecher Drilling Co., Casper, is contractor on the new extension test which Shell Oil Co. is starting in the Richey area, Dawson County, Montana. The test is 22-19 NPRR, in the SW SE NW 19-23n-50e.

Nichols-Duncan Drilling Co., Duncan, Okla., is starting an 8,500-ft. test for Vickers Petroleum Co. at 1 Phipps, SE SE NW 14-2s-3w, a mile north of Fox, Carter County, southern Oklahoma. The projected depth is expected to provide a look at the Springer sand, productive in several nearby fields.

Paul Guthrie Development Co., Edmonton, contracting for Dominion Minerals Development Co., Ltd., is starting a test at a wildcat location about ¾ mile from production in the new northeast extension area of the Campbell field, in Alberta Province, Canada. Location is in LSD 6, 35-54-25w4.

Herndon Drilling Co., Lyons, Kans., has a rig working for Flynn Oil Co. in Scott County, western Kansas. It is drilling 1 Harris, NE NE NE 19-18-22. It also is starting a test for itself in the same county, location being for 1 Barnett, NW NW SE 5-7-26.

Frontier Drilling Co., Denver, has two additional locations to drill for L. W. Winkler & Son and Phillips Petroleum Co. in the Pendroy area, Teton County, Montana. They are 1 Rice, NW SW NW 26-27n-5w, and 1 Porter, NE NE SE 27-27n-5w.

McIvor Drilling Co., Calgary, has the contract for a deep test which Anglo-Canadian Oil Co., Ltd., and associates are starting on the Duke of Windsor's E.P. Ranch, 40 miles southwest of Calgary, in southwestern Alberta Province. The location, in LSD 1, 1-17-3w5, is in the Pekisko area, about 7 miles south of the Turner Valley field, in the "Foothills" region.

Mountain States Drilling Co., Denver, has contracted for Husky Oil Co.'s second deep test in the Five Mile area, Big Horn County, Wyoming. Location, in the SE NW SW 12-49n-94w, on government-owned land, is 3½ miles northeast of the first well, 1 Torgeson, now being completed as a good gas-distillate producer in Embar lime with casing perforated at 11,964-82 ft. after being drilled to 12,283 ft. The second well is projected to the Phosphoria zone, expected around 12,100 ft.

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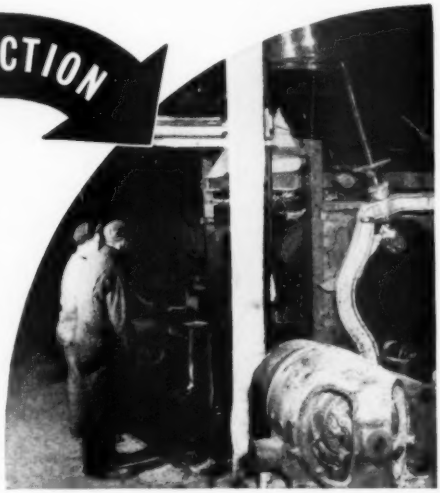

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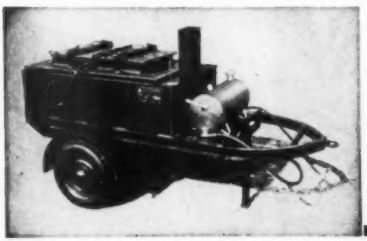

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PIPE LINES

Oil Lines in '51

Transportation volumes, revenues gain over 1950

WASHINGTON. — The nation's 52 largest oil pipe lines handled 445,000,000 bbl. more of crude and products last year and took in $75,000,000 more in transportation revenue than in 1950, it is disclosed by the Interstate Commerce Commission.

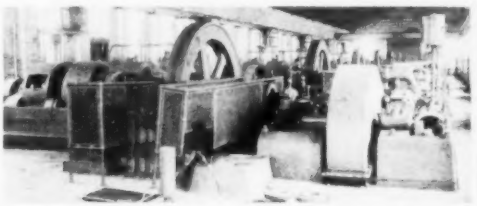
The 52 companies are those having annual operating revenues of more than $500,000. They handled 3,117,987,052 bbl. of oil last year against 2,672,779,930 bbl. in 1950 and had an aggregate transportation revenue of $483,904,491 against $408,585,889, the commission reported.

Not all companies shared in the increases in traffic and revenue. Nine reported less traffic and 10 showed reductions in revenue ranging from 0.2 to 41.4 per cent. In some cases companies handled more volume with less revenue, and in others they reported more revenue with less volume than in 1950.

Volume standings.—From the standpoint of volume, the leading pipeline companies were Humble Pipe Line Co., 303,396,698 bbl. against 240,819,256 bbl. in 1950; Texas Pipe Line Co., 201,102,727 bbl. against 169,129,453; Gulf Refining Co., 188,542,187 bbl. against 152,340,635; Interstate Oil Pipe Line Co., 176,480,642 bbl. against 168,619,800 bbl.; Service Pipe Line Co., 174,429,786 bbl. against 153,680,749 bbl.

Others moving in excess of 100,000,000 bbl. were Buckeye Pipe Line Co., 167,936,495 bbl. against 157,170,127 bbl.; Magnolia Pipe Line Co., 165,496,523 bbl. against 156,554,495 bbl.; Sinclair Pipe Line Co., 163,891,503 bbl. against 133,276,012 bbl.; Shell Pipe Line Corp., 139,177,159 bbl. against 116,699,159 bbl., and Ohio Oil Co., 138,972,395 bbl. against 128,824,125 bbl.

Revenue standings.—Topping the list in transportation revenue were Service Pipe Line Co. with $55,129,567 against $47,777,018 in 1950; Humble Pipe Line Co., $43,172,361 against $33,944,380; Sinclair Pipe Line Co., $37,069,273 against $31,490,578; Magnolia Pipe Line Co., $32,139,147 against $29,712,754; Gulf Refining Co., $30,211,581 against $26,899,142; Great Lakes Pipe Line Co., $29,468,209



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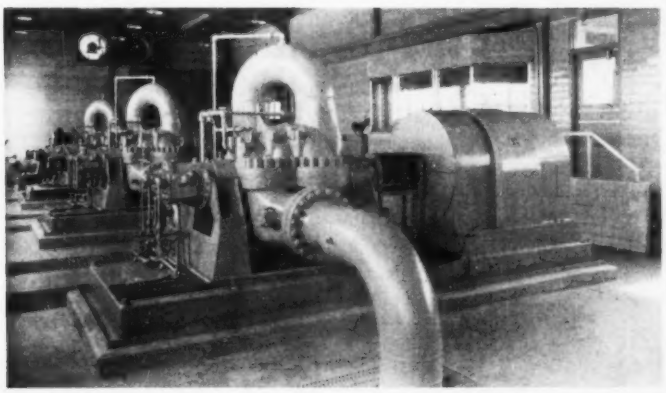
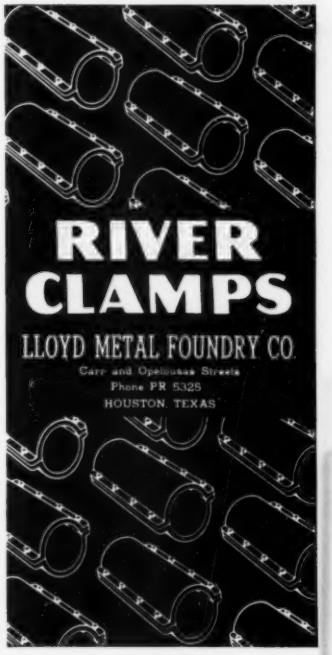


***THROUGHPUT TRIPLED.** — Until recently Shell Pipe Line Co.'s Wild Horse station in Osage County, Oklahoma, handled 85,000 bbl. of crude daily through two 10-in. lines. Seven 300-hp. diesel engines powered seven 10-in. reciprocating pumps. Now the station is handling 260,000 bbl. daily through one 10-in. and a 22-in. line. Three new 14-in., 780-r.p.m. centrifugal pumps, driven by Westinghouse induction motors, are used to handle the present throughput.*



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against $24,886,039; Texas Pipe Line Co., $29,602,417 against $23,553,488, and Shell Pipe Line Corp., $27,128,356 against $23,187,665. No other company reported revenue in excess of $25,000,000.

Welding Defects Discussed By Battelle Representative

TULSA.—Under-bead cracks and surface pits, two types of welding defects which are not the fault of the operator, were discussed by Perry Riepple, Battelle Memorial Institute, at the employe school conducted here by Industrial X-ray Engineers March 2-15.

Under-bead cracks occur at .003 to .005-in. below the weld metal and often are incorrectly called stringer-bead cracks. Riepple said they are the result of certain conditions which sometimes exist because of the high percentage of hydrogen in the gas shield around the welding arc. This is characteristic of modern pipe-line welding with the usual types of electrode coatings.

Preventive measures include preheating of pipe to about 400° F. or use of a shield of inert gas such as argon or helium. Preheating could be accomplished at a cost of approximately $10 per weld. Furthermore, under-bead cracks do not occur in submerged-arc welding of the types in the automatic processes, Riepple said.

Surface pits are caused by the combination of the hydrogen in the shield with sulfur in the metal. They have been found to occur when the sulfide content of the core wire exceeds .035 per cent.

Welding sleeves are regarded by Riepple as doing more harm than good. It would be better, he said, to make a good weld and grind it flush with the pipe.

The Industrial X-Ray Engineers organization emphasizes the significance of X-ray inspection as a means of controlling weld quality rather than for final inspection. By good sampling and utilization of information, it is possible to minimize cut-outs. Cut-outs or repairs are recommended only when there are obviously serious defects.

Algonquin Lets Contract For Connecticut Gas Line

TULSA.—Algonquin Gas Transmission Co. has awarded contract to Williams Brothers Corp. for construction of 140 miles of 26 and 24-in. line from New Jersey to the Connecticut River at a point midway between New Haven and Hartford, Conn.

The contract covers 135 miles of 26-in. and 6 miles of 24-in. plus crossings of the Housatonic and Naugatuck rivers. The Williams Brothers organization is moving equipment for

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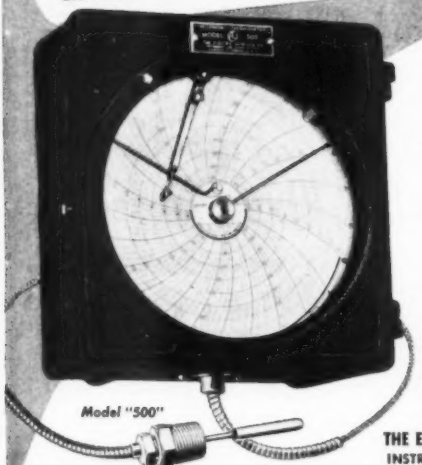

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three spreads which will commence work as soon as ground conditions permit. Most of the pipe has been delivered. Completion is scheduled for August 1.

United Authorized to Hook Up New Gas Production

WASHINGTON.—United Gas Pipe Line Co. has been authorized by the Federal Power Commission to build an 11-mile, 20-in. pipe line in Terrebonne Parish, Louisiana, to gather gas from Turtle Bayou and Kent Bayou gas fields.

The $1,461,000 line to hook into the company's existing system in the parish, will have a capacity of 143,000,000 cu. ft. of natural gas per day. United testified that there is an estimated 472,013,000,000 cu. ft. of producible gas in the two fields available to the company under contracts signed with Shell Oil Co. and Union Production Co.

Colorado Interstate to Expand System's Capacity

WASHINGTON.—Colorado Interstate Gas Co. has been authorized by the Federal Power Commission to go ahead with construction of natural-gas-transmission facilities which will boost capacity of its system from the present 368,000,000 to 452,000,000 cu. ft. per day.

Temporary authorization for construction of part of the facilities in 1952 was granted by the commission last December. These included 52 miles of main-line loop and lateral lines in Colorado, a boost in compressor capacity of the company's Panhandle field compressor station from 4,800 to 6,600 hp., and a 1,320-hp. increase in compressor capacity at its Kit Carson, Colo., station.

In 1953, Colorado Interstate will add another 2,640 hp. at its Panhandle field station and an additional 1,320-hp. unit at the Kit Carson station.

The entire project is estimated to cost about $3,379,532.

Ohio Fuel Gas Gets FPC Approval for 30-Mile Line

WASHINGTON.—Ohio Fuel Gas Co., Columbus, has received a Federal Power Commission o.k. for construction and operation of a 30-mile, 20-in. pipe line in central Ohio.

The new $1,440,000 line will be built from the company's Treat compressor station in Licking County to its Weaver station in the Richland County underground-storage area. It would be used to transport and store more gas in the northern part of the company's system. Capacity of the new line is estimated at 142,000,000 cu. ft. per day.

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REFINING

Aromatics Short

Egloff says high demand must be met by refiners

HOUSTON.—Increased participation of petroleum refiners in the field of aromatics production is necessary to prevent a serious dislocation in the domestic economy, according to Dr. Gustav Egloff, Universal Oil Products Co.

Speaking to a large group of industry representatives here during the recent unveiling of Eastern States Petroleum Co.'s new aromatics-extraction and platforming units, Egloff said demands for benzene now exceed projected capacity of steel-industry coke ovens, which formerly were the sole source of the product.

The impact of the shortage of benzene is revealed in manufacturers' reports that they have held back the construction of detergent-manufacturing facilities due to the tight benzene supply.

Markets.—Benzene from the new units at Eastern States' refinery, he said, will be used to produce styrene, essential material in the production of synthetic rubber and base for polystyrene plastics.

Total styrene production, he predicted, should reach 750 million pounds by 1952 and 1 billion pounds by 1955. Such an expansion would require a heavy increase in benzene-production capacity.

Phenol is the next largest consumer of benzene and requires benzene whether the phenol is produced by old or new synthesis methods. The markets for phenolic products is expected to double in the 5-year period from 1950 to 1955, he said.

Nylon, which ranks third as a consumer of benzene, is in continued demand, and the market for nylon will continue to grow for many years notwithstanding the developments in the field of synthetic fibers.

Another large market for benzene is the synthetic-detergent field, where the detergents have already replaced about half of the soap market, and demand is believed to be far in excess of supplies.

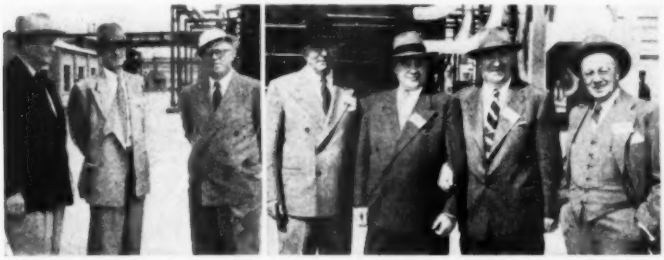
Other aromatics.—Toluene, also obtained from petroleum, has been used extensively in making TNT and as an important solvent. The benzene shortage has prompted the exploration of possibilities whereby toluene may be used as a substitute for benzene, Egloff said. For instance, some classes of detergents are made from toluene as well as benzene, and vinyl toluene has been found an adequate and sometimes superior substitute for styrene in a number of products, he said.

Other C_8 aromatic hydrocarbons produced by platforming have a high potential value. These include ortho, para, and meta xylenes and ethylbenzene. The xylenes have been used for making phthalic anhydride and the new textile, Dacron. Ethylbenzene can be used as raw material for styrene.

New Analytical Computer Speeds Product Analyses

NEW YORK.—Petroleum-product analyses will be speeded up 10-fold by a new combination of two complex electronic instruments.

Termed the "Miniac," the computer consists of an electronic counter linked with a mass spectrometer. The instrument was developed for Atlantic Refining Co. by Physical Research Laboratories of Pasadena, Calif., and was the subject of a paper delivered by Dr. W. S. Young of Atlantic's Philadelphia research staff, at the



OPEN HOUSE.—Attending the recent unveiling of Eastern States Petroleum Co.'s new aromatics-recovery and platforming units at the company's Houston refinery were (left to right): R. B. Kahle, president of Eastern States; H. B. Herren; D. D. Henson, vice president in charge of refining for Eastern States; Sanford Wagner, Ethyl Corp.; P. E. Frank, Sinclair Refining Co.; J. F. McCarthy, vice president of Eastern States, New York; and Milo Wilder, Jr.

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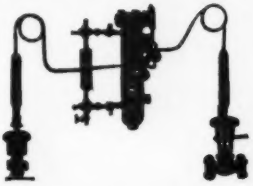

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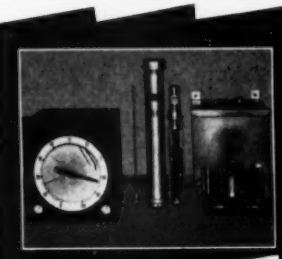

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The new instrument will analyze a mere trace of gas or liquid and in a matter of minutes record the complete chemical composition on a typed sheet of paper. According to its designer, George Green, it can also be used separately on many other problems which require high-speed complex calculations. When so used, it can compute at the rate of 100,000 digits per second, more than 10,000 times the speed of the fastest human with pencil and paper.

An important link in the combination of Miniac with the mass spectrometer was a "selector" designed for Atlantic by Consolidated Engineering Corp. of Pasadena. The combination instrument, 2 years under development, now is nearly ready to be put in operation at Atlantic's research laboratories at Philadelphia. The new development will be made available to industry at large.

Avgas Output Up in 1951

WASHINGTON.—Production of all grades of aviation gasoline in this country in 1951 amounted to 72,168,000 bbl., according to the latest monthly petroleum statement released by the Bureau of Mines.

This figure represented an increase of 20,986,000 bbl. or 41 per cent over production in 1950. Production of all motor fuel, including automotive gasoline, increased 11.2 per cent.

Exports of avgas for the year increased 72.3 per cent to 12,156,000 bbl. Domestic demand, including military purchases, totaled 53,061,000 bbl. for a gain of 34.3 per cent.

In the process of blending to meet specifications, 5,894,000 bbl. were transferred to other products.

Total demand included 55,091,000 bbl. of 100-octane and above, 8,866,000 bbl. of other finished grades, and 1,260,000 bbl. shipped as components for blending outside refineries.

Refining Briefs

Frank H. Dunn, president of Wilcox Oil Co., Tulsa, predicts that the company's new platforming unit, now under construction at its Bristow, Okla., refinery, will be in operation by October if deliveries of materials continue on schedule. The 1,500-bbl. unit is being erected by Procon, Inc., and will cost approximately $1,000,000.

Morton-Withers Chemical Co. plans to construct a $1,780,000 plant to synthesize petroleum sulfonates on the Gulf Coast in Texas or Louisiana. Now operating a "commercial pilot unit" at Greensboro, N. C., the company shipped its first products from that point last month. A certificate for accelerated amortization has been granted for the new plant. It will be located on the Gulf Coast because of the proximity of both raw materials and markets.

PROMPT SHIPMENT FROM DALLAS STOCK

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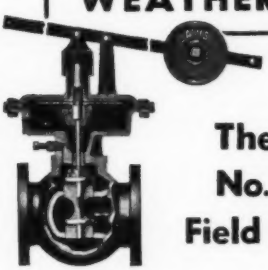

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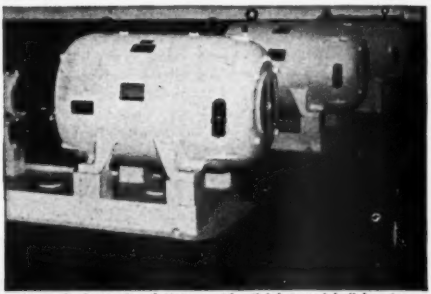

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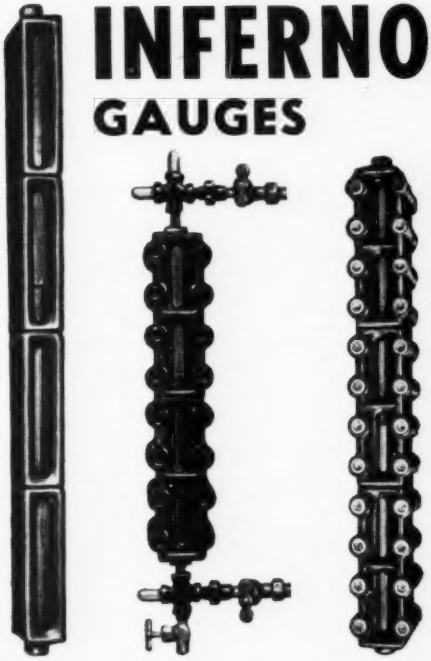

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NATURAL GAS

El Paso Buys San Juan Gas Interests on 80,000 Acres

DALLAS.—Gas interests in 80,000 acres of lands in the San Juan basin of northwestern New Mexico have been sold to General American Oil Co. of Texas to El Paso Natural Gas Co. for about $1,300,000.

General American said El Paso will take over operation of the leases immediately and intends to begin an active drilling program soon.

Terms provide for payment by El Paso of $500,000 in cash with the remaining $800,000 to come from sales of gas from the acreage. General American will retain one-fourth interest in the lease free of development costs, but subject to its proration of operating expense. The company also will continue oil exploration in the area. It will sell any gas wells it finds to El Paso and will buy any oil wells found by El Paso.

Four New Firms Protest Texas Gas-Gathering Tax

AUSTIN.—Four new pipe-line firms have joined those protesting Texas' gathering tax on natural gas, tabulations for January disclose.

The state comptroller's office said those firms protesting for the first time included Colorado Interstate Gas Co., $44,327.44; Kerr-McGee Oil Co., Inc., $5,121.18; Southern Natural Gas Co., $5,692.67; and West Texas Utilities Co., $5,060.13.

January tax took in $1,048,737.10 from 186 companies and individuals. Of this sum $652,251.23 was paid under protest by 76 firms and was placed in escrow.

These figures compared with total collections of $1,052,637.94 in December of which $626,625.42 was protested.

Oklahoma to Defend FPC Ruling in "Phillips" Case

OKLAHOMA CITY. — Oklahoma, through State Atty. Gen. Mac Q. Williamson, announced its intention last week to intervene against a court appeal filed by several northern states and cities to set aside the Federal Power Commission's decision in the so-called Phillips case.

FPC held last fall that its jurisdiction did not enable it to set gas rates where the seller is an oil company doing business with gas-distributing companies.

Williamson will be assisted by Floyd Green, Oklahoma Corporation Commission attorney, who said the action is being taken in the interest of conservation. Waste would be encouraged if FPC should be allowed to set rates and they should prove too low, Green said.

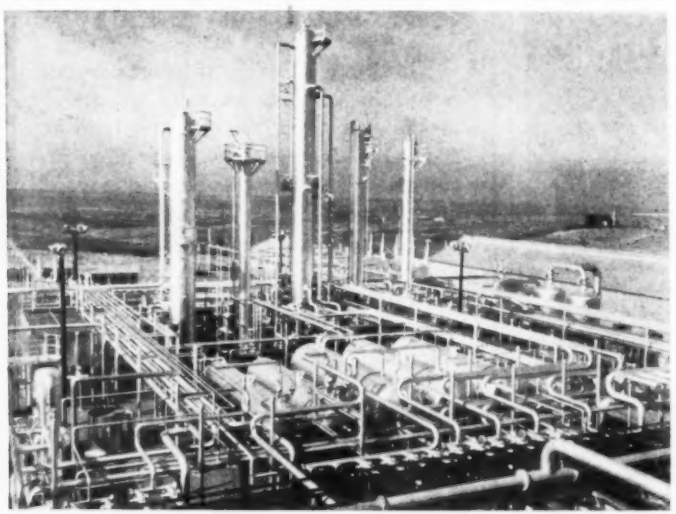
The court test of the FPC decision has been filed in the U. S. Circuit Court of Appeals in Washington by the State of Wisconsin, Wayne County in Wisconsin, and the cities of Detroit, Milwaukee, and Kansas City, Mo.

Texas, New Mexico, and possibly other oil-producing states are expected to join Oklahoma in defense of the FPC ruling, Williamson said.

Sales Up 11 Per Cent

NEW YORK.—Sales of natural gas during the first month of the new year were running about 11 per cent ahead of volumes sold in January 1951, the American Gas Association reports.

Sales totaled 5,256 million therms, compared with 4,743 million therms in January 1951. The A. G. A. index of natural-gas sales in January was 430.2 per cent of the 1935-39 average.



EXPANSION AT CRAWFORD.—Skelly Oil Co. recently completed installation of a new 660-hp. Ingersoll-Rand compressor unit at its Crawford cycling plant near Skellytown, Tex. It is used for repressuring gas to the Watkins repressure area. With the exception of a few added cooling coils no expansion of plant gas-handling facilities was necessary, since these facilities were originally sized for the additional load. The Crawford plant now processes up to 14,000,000 cu. ft. of wet gas daily. Repressure of dry gas varies from 8,000,000 to 14,000,000 cu. ft. daily (latter figure is compressor capacity).

Natural Gasoline

Cities Service Plans New Plant Near Blackwell, Okla.

BARTLESVILLE, Okla. — Cities Service Oil Co. (Del.) will kick off construction soon of a natural-gasoline plant near Blackwell, Okla.

S. B. Irelan, company president, said the plant will have an initial capacity to produce about 200,000 gal. of liquid products. It will be located on a 160-acre tract about 2 miles northwest of Blackwell and is expected to be in operation by early 1953.

The project includes a pipe line for moving products to the recently modernized Cities Service refinery at Ponca City, Okla. The company's tank-car fleet will be enlarged by about 250 high-pressure cars to handle movement of the L.P.G. production to underground-storage locations and other distribution points.

Sun Plans Storage Project

AUSTIN.—Sun Oil Co. is planning construction of a 100,000-bbl. L.P.G. underground-storage project in Spindletop field of Jefferson County, Texas.

In recent hearings before the Texas Railroad Commission, Joe Owens, Sun representative, told Examiner Martin Allday that the company proposes to drill a well through the caprock to a salt formation expected at about 900 ft. where the cavity would be washed out.

THE EXPERIENCE OF A PIONEER CANNOT BE ACQUIRED OVERNIGHT

The men who led the westward movement of our people across America's plains and mountains had to learn many of their lessons from one unfailing teacher. That teacher, then and to this day, is Experience. There is no substitute for it. You cannot enjoy its benefits by reading about it, nor merely by copying the actions of others or voicing, parrot-like, their well-learned principles. This is as true in learning how to protect fuels, lubricants and machinery from dirt as it was in learning how to protect those pioneering settlers from hunger, thirst or the attacks of savages. So we say: *The makers of Winslow Filters and Elements have been pioneering the principle and successful application of Full-Flow filtration for nearly twenty years.* We take pride in original patents which we hold, and we congratulate those other manufacturers who are finally beginning to endorse the same ideas. But to those of you who are buying *full-flow filters*, we repeat: The experience of a pioneer cannot be acquired overnight. For added value born of experience, specify Winslow Filters!

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"NEVER ANY DOWN TIME"

says Manager, Herbert Miller

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● Just north of Edmonton, Alberta, at Miller Bros.-Campbell No. 1 Well (when the rig was photographed) with temperature at zero—but the Waukesha Diesels kept right on making hole. This well, now going on production, was drilled to 3724 ft. The rig has drilled four holes, three of them producers, or about 35000 ft., in approximately 14 weeks. It's a Model R *Cardwell* with 87-ft., two-pole mast, 7-ft. sub-structure; and a 5 x 10 *Gardner-Denver* mud pump; each powered by a 148-DKU Waukesha Diesel Oil Field Unit.

"These engines give me the power when I need it," says the rig's tool pusher, Harry Knight. And, as Herbert L. Miller, Manager of Newport Drilling & Servicing Co., Ltd., who own and operate the rig, sums it up, "We have never had any down-time due to the failure of these engines and you can be sure that on our next rig we want Waukeshas." Get Bulletin 1414.

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.
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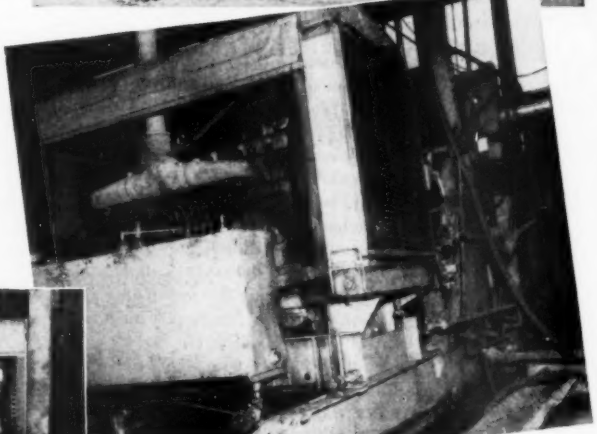
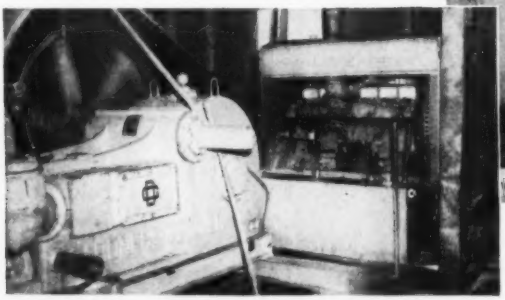




Drilling rig (above) and mud pump (*left*) are each powered by **WAUKESHA Model 148-DKU DIESEL**, 6-cyl., 5¼-in. bore x 6-in. stroke, 779 cu. in. displ.; that burns all "high speed Diesel fuels" cleanly, with lively acceleration, high economy, easier starting.

WAUKESHA *Diesel Power* ... *Gas Power* ... POWER

165

Lorac Goes Into Operation

THE first commercial installation of Lorac, Seismograph Service Corp.'s radio surveying and navigational system for use by geophysical survey parties in the Gulf of Mexico, began positioning operations last week.

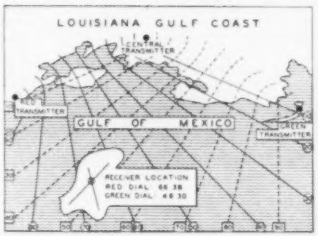
As its name indicates, Lorac (LOng Range ACcuracy), makes possible the accurate determination of the position of ships on the water at long range. Various devices developed for military use during World War II are now being used for positioning ships in the gulf, but they have not proved entirely satisfactory, principally because of their "line of sight" limitation. (Even with 100-ft. towers on shore the current methods are limited to about a 20 to 25-mile range.) The use of Lorac will permit accurate position fixing out to 100 miles.

The new installation consists of three transmitting stations on the Louisiana coast. One station (red end station) is located about 10 miles south of Abbeville; the central shore station is near Centerville; and the third station (green end station) is located about 20 miles south of Houma. The distance between the central station and either end station is about 40 miles with an over-all base-line length of 80 miles.

All three transmitters are 500 watts with 100 ft.-high antenna masts. Frequencies used are 1772 and 1798 kilocycles per second. A radio tuned to either one of these frequencies would give out alternate audio notes of 240 and 600 cycles. Call letters of the stations are KK2XBA, KK2XBB, and KK2XBC.

The initial geophysical work using this system is being carried out by a major company operating with three receiver-equipped ships. The Lorac installation now in use covers a water area of nearly 10,000 sq. miles in which any ship equipped with S.S.C.'s receiver can accurately locate itself. There is no limit to the number of ships that can successfully and simultaneously utilize the emissions from the shore installations now in operation and there is to be no discrimination in supplying the service.

In 1950 a Lorac network was installed along the Texas Gulf Coast and tests were conducted with geophysical crews operating offshore. In these tests the coastal coverage was about 75 miles and the seaward coverage about the same distance. Repeatability tests performed during this experimental work showed positioning errors from all causes to be only a few feet. (In theory, using 2000 kc. per second the reading accuracy is plus or minus 2½ ft.)



The basic principle employed by the Lorac system is essentially that of measuring the phase difference of the radio waves received from two continuous-wave transmitters. The radiations from these transmitters produce a hyperbolic interference pattern with the transmitters at the foci. Constant phase differences exist along any given hyperbola but a phase meter moving across one of these hyperbolic lines changes its reading. When transmitters are so placed that hyperbolas of one pair intersect with those of another pair, a grid is formed (see sketch). Thus, by reading two phase meters, a position fix can be made at any time: the two dial readings give a position determination on the hyperbolic coordinate system and an overlay places the fix on a geographic map.*

Operation of the receiving ship is simple. Position information is obtained by direct reading of coordinate figures from the phase meters aboard a ship and can be plotted without computation into a precise position fix on the Lorac chart. No dial manipulation or matching of pips is required. Operations may be carried out under conditions of heavy static or electrical interference.

Though all exploratory work in the Gulf of Mexico is not waiting for now-pending legislation on control of the submerged lands off the nation's coast, it is running at a low rate. When exploration gets going in earnest it is anticipated that all of the water off the coast of Texas and Louisiana will be covered by Lorac systems.

Philip C. Ingalls.

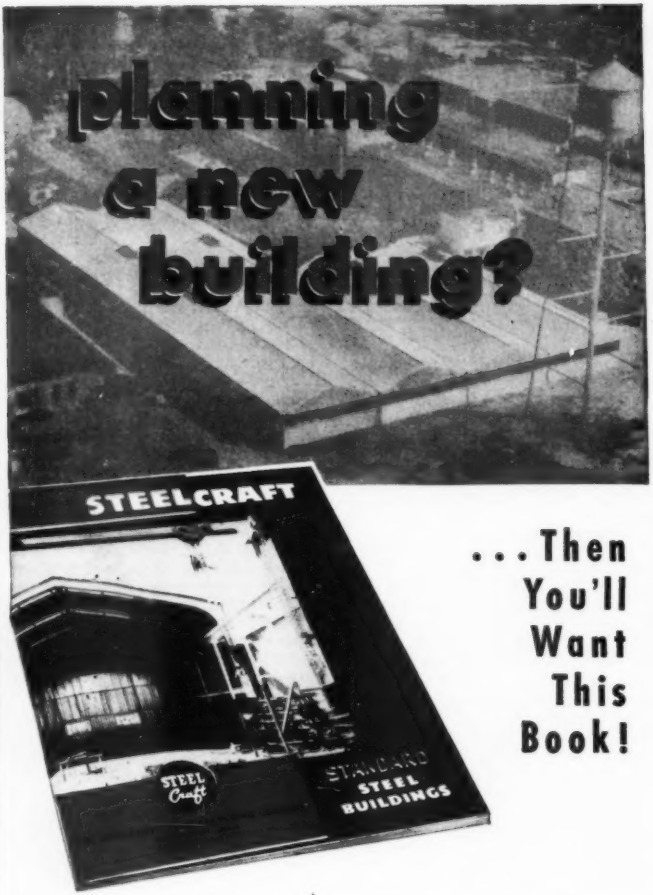
*Details of this system of surveying were given in the June 17, 1948, issue of the Journal.

HIGHLIGHTS OF WEEK'S DEVELOPMENTS

NEBRASKA.—Argo Oil Co. and True & Brown have found staining in the Dakota zones at 1 Kahl, NW NW SE 6-13n-40w, an important wildcat in the Northwest Bruel area, Keith County. Staining was discovered in cores of 13 ft. of sand in the zone from 3,094-3,142 ft., and the operator is preparing to test. This well is the eastern-most in the Denver-Julesburg basin to discover stains in the Dakota zones.

EASTERN TEXAS.—The Big Mineral Creek field of Grayson County reported its first completion in the deep Oil Creek sand, which produces gas and distillate and is separated from the other Oil Creek producing areas by a 3,000-ft. fault. On official test Talbot Oil Co. 1 Hazlip flowed 95,000 M.c.f. of gas daily, plus 50 bbl. of distillate per 1,000,000 cu. ft. from perforations at 10,138-160 ft.

MISSISSIPPI.—One of the most significant strikes in the southeastern United States in several years has been completed in Monroe County at Union Producing Co. 1 J. T. Sanders, 22-15s-6e. The reworked dry hole proved to be a big gas-condensate well with a calculated open flow potential of 35,000 M.c.f. of gas daily plus an estimated 10 bbl. condensate per million cubic feet of gas from 5,186-5,274 ft.



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Southwest Texas

Duval County Wildcat Tests Oil in Hiawatha

CORPUS CHRISTI.—Pontiac Refining Co. 1 LeRoy Denman, wildcat 5 miles south of Realitos in Duval County, tested oil on drill-stem test at 5,050-58 ft. in the Hiawatha zone. Through ¼-in. choke, the well yielded 270 ft. of oil and 20 ft of salt water. This well had previously tested gas on tests at 4,926-44 ft.

Southern Minerals Corp. 1 Nellie I. Fischer, wildcat in the East Riverside area of San Patricio County, is coring ahead at 4,279 ft. after recovering gas-distillate on drill-stem test. On an 8-minute test at 4,227-35 ft., using ¼-in. chokes, maximum working pressure was 500 psi. and recovery was 5 ft. of distillate and 5 ft. of distillate-cut mud. Below this interval, two thin streaks of shaly sand with oil odor were cored between 4,235-79 ft.

Ten miles northeast of Encino, Humble Oil & Refining Co. 1-98 Robert J. Kleberg, Jr., Trust - Sacahuistal Pasture, Brooks County wildcat, started flowing oil in an undetermined amount when operator was going in the hole with drill-pipe. Hole is bottomed at 11,671 ft. The wildcat is bottomed in W. H. Schlake survey 98.

Houston Oil Co. and American Republics Corp. 1 Temple West, gas-distillate discovery in Porcion 74, Hidalgo County, is shut-in waiting on potential test. Drilled to 6,703 ft., operator set 5½-in. casing at 6,197 ft. and perforated from 6,048-58 ft. The well was acidized and started flowing an unestimated amount of gas, distillate and mud through ¼-in. choke.

Sunray Oil Corp. 1 Esubio Perez, Jim Wells County prospective oil discovery, is swabbing on perforations in the Caddo sand. On a 10-hour drill-stem test of perforations at 3,612-22 ft., the well recovered 150 ft. of oil plus some oil-cut mud. When swabbed, recovery was an estimated 2 bbl. of oil per hour and 80 per cent salt water. Before swabbing was continued, the well was shut in overnight. When the hole filled, recovery was 500 ft. of oil and 2,600 ft. of fresh water. This wildcat is located in SK &K survey, 3½ miles northwest of Premont.

A new gas pay is indicated in West Alfred field, Jim Wells County, at Bridwell Oil Co. 1 Gertrude Hoffhines, William Parks survey 29. On drill-stem test at 2,662-67 ft., the well flowed an unestimated amount of dry gas. Bottom-hole pressure registered 920 psi. The well is now coring below 3,070 ft.

SOUTHWEST TEXAS (DISTRICTS 1 AND 4) SUCCESSFUL WILDCATS

San Patricio County: Gas distillate discovery—LaGloria Corp. 1 N. L. Wilson, Geo. H. Paul Subd., J. J. Welder Ranch, Sec. 66, TD 6,120 ft., Frio 5,224-28 ft., IP 6,100,000 cu. ft. of gas daily plus 15 bbl. of distillate per million, ¼-in. choke, TP 1,475 psi.

Webb County: Oil discovery—O. W. Killam 3 J. O. Walker, Gutierrez Pasture, J. V. Borrego Grant, TD 2,407 ft., upper Rosenberg 1,677-87 ft., IP 74 bbl. oil per day, 25°-gravity.

SOUTHWEST TEXAS (DISTRICTS 1 AND 4) WILDCAT FAILURES

Atascosa County: Martin, Shelly et al 1 A. C. Soechting Peter MacCreal Sur. 1293, dry, TD 2,005 ft.

Paisano Trading Co. et al 1 Caswell-Bud-Anderson, Maria Delores Diaz Sur. 50, A-189, dry, TD 3,106 ft.

Bexar County: Sid Katz 1 F. T. Keepers, S. T. Priest Sur. Sec. 5, dry, TD 3,478 gt. Robert Ross Sur. 1 Felix Turner, Jose Angel Navarro Sur., dry, TD 1,504 ft.

Dimmitt County: Spartan Drilling Co. 1 N. C. King, Blas Reyes Grant, A-4, dry, TD 4,717 ft.

Duval County: Harris S. Stahl 1 The Duval County James Dougherty Surf., AB&M Sur. 205, Cert. 1,013, dry, TD 3,914 ft.

Frio County: Rycade Oil Corp. 1 Lang & Oppenheimer, Baker Sur., Sec. 64, Blk. A-71, dry, TD 5,125 ft.

Jim Wells County: Kirkwood & Co., Jergins & Anderson 2 Givens B. Parr, Scotts Resubd. of Benton Pasture, Sec. 11, Blk. 5, dry, TD 6,360 ft.

Weldon H. Smith 1 Lynn L. Dugger, F. B. Nichols Sur. 17, Tract 1, dry, TD 5,210 ft.

Texita Oil Co. 1 W. A. Davis, T&NO RR Sur., A-503, dry, TD 3,600 ft.

Williamson County: S. M. Messer 1 Armstrong, Peter Cartwright Sur., dry, TD 948 ft.

Zapata County: Eugene Garner 2 Marshall et al Sur. 288, Blk. 4, dry, TD 993 ft.

Mississippi

Discovery Well of New Muldon Field Completed

JACKSON.—What is considered to be one of the most significant strikes in the southeastern area in several years has been completed in Monroe County, Mississippi. The discovery well of the new Muldon field is Union Producing Co. 1 J. T. Sanders, 22-15s-6e, has been completed for a calculated open flow potential of 35,000,000 cu. ft. of gas per day with rock pressure of 2,003 psi. An accurate gage of condensate production could not be obtained, because of equipment trouble, but is being estimated at 10 bbl. per million cubic feet of gas. On various chokes during the test, estimates of condensate production ranged from 7 bbl. of 18 bbl. per million cubic feet. The fluid is water clear and is very high gravity, being 66.2°.

The exact section from which the well is producing is not known. This well is an old abandoned strat test which was abandoned at 6,060 ft. in Tuscumbia lime. Hole was cleaned out to 5,274 ft. and casing cemented at 5,186 ft. Completion is from open hole below the casing, and production can be coming from any of the Mississippian section explored.

Meanwhile, Union is now drilling below 1,900 ft. on a northwest diagonal offset to the discovery and is building roads to a 3 mile east outpost well, 1 Watkins, 31-15s-7e.

Lion Oil Co. is coring again at 2 Denkmann, 22-7n-4e, deep Smackover wildcat in Rankin County, after being delayed on a fishing job for a small piece of steel. Operators drilled 3 ft. of hole from 16,025-28 ft. while cleaning out, and then cored 16,028-40 ft. with recovery being 8½ ft. of the same grey, porous permeable sand that was topped at 15,977 ft. This now makes a total of 43 ft. of this sand to present depth. There is no evidence or indication of exactly what occupies the pore space in this sand. It is reported that operators plan to continue coring until salt is encountered unless mechanical difficulties arise.

A. Q. Petersen has abandoned 1 Wallace, 18-2n-1w, wildcat in Wilkinson that had shows of oil in the Wilcox at 8,231-35 ft. This well was abandoned without setting casing.

Southeast of the one-well Gardens field, in Adams County, B. Serio has abandoned 1 Miller, 12-7n-3w, after several attempts to complete in a sand which carried shows at 4,412-21 ft.

MISSISSIPPI SUCCESSFUL WILDCAT

Marion County: Gas-condensate discovery—Union Producing Co., 1 J. T. Sanders, 22-15s-6e, TD 6,060 ft., perf. 5,081-82 ft., IP 35,000,000 cu. ft. of gas per day plus some 66.2°-gravity distillate, TP 1,500 psi., CY 1,700 psi.

MISSISSIPPI WILDCAT FAILURES

Adams County: B. Serio 1 C. C. Miller et al, 12-7n-3w, dry, TD 6,314 ft.

Forrest County: W. B. Ulmer et al 1 Ran Batson et al unit, 21-1s-14w, dry, TD 8,304 ft.

Jefferson County: Shell Oil Co. 1 Newman

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Lumber Co. et al unit, 12-5n-19w, dry, TD 10,002 ft.

Wilkinson County: A. Q. Peterson 1 Sareste W. Wallace, 18-2n-1w, dry, TD 8,522 ft.

South Louisiana

Good Oil Discovery Due In Plaquemines Parish

NEW ORLEANS.—Woods Oil and Gas Co. apparently has a good oil discovery iin Plaquemines Parish at 1 Dr. Benjamin Slater, 6-18s-24e, located on the east bank of the Mississippi River opposite the Potash area. The well logged a 101-ft. sand section containing oil, gas and some distillate. Operator perforated at 11,215-27 ft., and 11,228-39 ft., and after tool was open 3 hours, the well cleared itself, and started flowing 32.8°-gravity oil under tubing pressure of 3,600 psi. No test has been run on the venture, but it is estimated that production will be about 300 bbl. daily.

Kerr-McGee and Stanolind Oil & Gas Co. are preparing to test their Cameron Parish wildcat, 1 C. F. Henry, 29-14s-9w, which logged a gas-distillate sand from 9,130-55 ft. and 9,315-60 ft. The test has 7-in. casing set 3 ft. off bottom at 9,425 ft.

Testing operations are underway at two Pan American Production Co. wildcats in Cameron Parish. Drill-stem test was run at B-1 Miami Corp., 14-5s-4w, 1½ miles south of the Grand Chenier area. From perforations at 12,564-70 ft., the well flowed gas and distillate for 1½ hours, through ¼-in. bottom and ⅛-in. top chokes. These perforations were squeezed off and operators are now testing at 12,508-64 ft.

One-half mile south of Pecan Lake discovery well, Pan American 2 Miami Corp., 9-15s-3w, completed a 15-hour drill-stem test flowing 2,985,000 cu. ft. of gas plus 61 bbl. 48.4°-gravity condensate. Production was through perforations at 10,760-74 ft. These perforations were left open and operator went deeper into the hole to perforate at 11,292-11,306 ft. At this interval, the well tested gas-condensate with surface pressure of 3,050 psi.

A prospective Terrebonne Parish discovery is Cities Service Oil Corp. and Forrest Oil Co. 1 Delta Securities, 37-17s-18e, which is now drilling below 12,618 ft. on a 13,000-ft. contract. Cores and electric log indicated about 150 ft. of net gas pay in the well. This wildcat is located on a block of about 1,700 acres, and nearest production is in the Lake Long field four miles to the southeast.

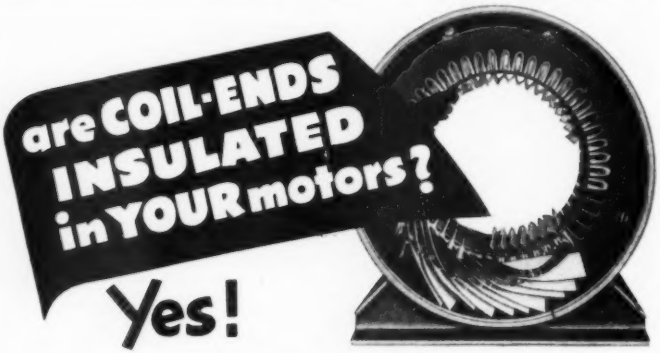
Magnolia Petroleum Co. is testing 1 Ragley Lumber Co., 29-5s-7w, Allen Parish, which shows promise of being the world's deepest producer. The well had gas shows from 18,586-18,660 ft.

SOUTH LOUISIANA SUCCESSFUL WILDCAT

Plaquemines Parish: Oil discovery — The California Co. 1 St. Lse. 1958, offshore, TD 10,000 ft., perf. 7,528-32 ft., IP 244 bbl. oil per day, ⅛-in. choke 29°-gravity, TP 1,000 psi.

SOUTH LOUISIANA WILDCAT FAILURE

St. Bernard Parish: John L. Loeb 1 St. Lse. 1825, 13s-15e, dry, TD 9,700 ft.



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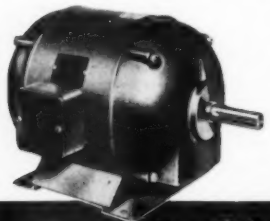

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Kansas

Dual-Zone Oil Discovery Extends South Gates Pool

PETROLEUM, INC., has a dual-zone oil discovery at its 1 Gates, SE NE NW 3-22-13, a half mile southeast of production of South Gates pool in northern Stafford County. Good showings were obtained in both the Lansing-Kansas and Arbuckle zones. The former zone was topped at 3,362 ft. A 60-minute drill-stem test of an interval at 3,540-56 ft. recovered 1,320 ft. of oil with 180 ft. of muddy oil. Indicated bottom-hole pressure was 1,070 ft. Top of the Arbuckle was logged at 3,739 ft. and a 60-minute drill-stem test at 3,745-60 ft. recovered 3,120 ft. of oil with bottom-hole pressure of 1,190 psi.

Swabbing tests are under way by Ben Brack at his 1 Alefs, NE SW SW 14-19-14, a wildcat located just west of Great Bend, Barton County. Bailing, the well produced 1½ bbl. of oil per hour. As this is written no estimate has been made of the swabbing recovery. Prospective pay zone is the Arbuckle topped at 3,474 ft., and drilled to 3,477 ft. Hole is open below 3,457 ft., where oil string was run. Promising oil showings previously had been made of various intervals in the Lansing-Kansas City lime from 3,212-3,379 ft. Top was logged at 3,208 ft. (—1,331 ft.). Best showing was in an interval at 3,325-38 ft., where a 30-minute drill-stem test got 120 ft. of free oil with 210 ft. of mud. Nearest other production is 1½ miles to the west in the Heizer pool.

Murfin Drilling Co. is making what appears to be good well at its 1 Dancer, NE NE NW 4-8-17, which opens a new producing area located about a mile northeast of the Lone Star pool, 5 miles southeast of Stockton, Rooks County. The well produced initially at the rate of 15 bbl. of oil per hour by swabbing following acidization, using 1,000 gal. and now is being put on the pump. Production is from the Lansing-Kansas City lime section, topped at 3,055 ft. and opposite which casing is perforated at 3,148-52 ft. and 3,140-46 ft. Arbuckle lime, topped at 3,349 ft. and penetrated to 3,355 ft., did not show for commercial production. Casing was run to 3,350 ft.

KANSAS SUCCESSFUL WILDCATS

Barber County: National Associated Petroleum Co. 2 House "A", SW SW NW 16-

30s-12w, pumped 8 bbl. oil from Viola, 4,513-18 ft., TD 4,525 ft. (extends Amber Mills pool)

Trego County: Deep Rock Oil Corp. 1 Zeman, SE SE SE 21-14s-21w, pumped 248 bbl. oil from Lansing 3,849-62 ft., TD 3,955 ft. (opens Sunny Slope pool)

KANSAS WILDCAT FAILURES

Butler County: Wagoner 1 Joseph, NE NE NE 22-24s-4e, dry, TD 2,615 ft.

Eckland et al 1 Knox, NE NW SW 17-27s-7e, dry, TD 2,706 ft.

Cowley County: Bishop-Atlantic 1 Priest, NE NW SW 7-33s-6e, dry, TD 3,113 ft.

Edwards County: K. Ellison 1 Budde, NE NE NE 8-24s-18w, dry, TD 4,550 ft.

Ellis County: Lindas Oil 1 Dreiling, SW SW SE 3-14s-16w, dry, TD 3,445 ft.

Graham County: Jones, Shelburne & Farmer 1 Noah, NW NW NW 21-10s-21w, dry, TD 3,957 ft.

Norton County: Empire Drilling Co. 1 Schuck, SW SW NW 31-5s-22w, dry, TD 3,992 ft.

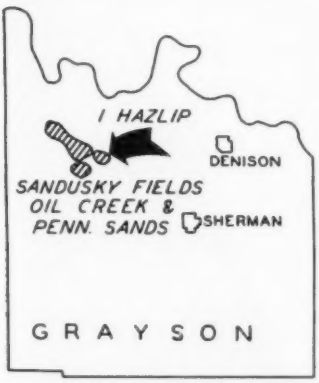
Musgrove Petroleum Corp. 1 Hickert, NE NW NW 19-5s-24w, dry, TD 3,930 ft.

Osborne County: Musgrove Petroleum Corp. 1 Worley, SW NW NW 35-10s-15w, dry, TD 3,544 ft.

Eastern Texas

Big Mineral Creek Field Has Oil Creek Completion

DALLAS.—The Big Mineral Creek field of Grayson County this week had its first completion in the deep Oil Creek sand, which produces gas and distillate and is separated from the other Oil Creek producing areas by a 3,000-ft. fault. The new well, second to find the distillate pay, had a high yield of 50 bbl. of oil per 1,000,000



cu. ft. of gas, which could greatly alter the picture if an outlet is provided.

Talbot Oil Co., a Tulsa concern, 1 R. W. Hazlip, is located in the William Allen Survey, A-15. On Railroad Commission tests the well flowed at the rate of 95,000,000 cu. ft. of gas daily, plus 50 bbl. of distillate per 1,000,000 cu. ft., from perforations at 10,138-160. Total depth was 10,806 ft. and casing was set to 10,227 ft. Top of the sand pay was 10,073 ft. A drill-stem test on the section, through ¼-in. top and bottom chokes, flowed some 15,000,000 cu. ft. of gas a day with flowing pressure at 4,728 psi.

The 1 Hazlip is ½ mile northwest of George Humphrey 1 Barnes heirs, which found deep gas-distillate pay but plugged back and completed from a shallower sand.

In Wood County, Sun Oil Co. 1 R. H. McCrary flowed 222.8 bbl. of oil a day on Railroad Commission potential. Production was from the sub-Clarksville sand at 4,408-18 ft.

Bowie County had a prospective Paluxy sand discovery at American Liberty Oil Co. and others' 4 T. A. Jackson, T&P Survey, 2 miles southeast of Dalby Springs. Drill-stem test in sand at 4,362-74 ft., total depth, developed 300 ft. of 22°-gravity oil. Operators were running casing to complete. Location is a north offset of the 1 Jackson, which found the oil sand but was drilled into water. American Liberty was said to hold some 3,000 acres in the area and were planning on its developing into a 40-well field. A pipe line is to be laid to Dalby Springs, and trucked from there to American Liberty's refinery at Mount Pleasant.

EAST TEXAS (DISTRICTS 5 AND 6) SUCCESSFUL WILDCAT

Marion County: Renwar Oil Corp. 1 Wallace Johnson, J. Johnson Sur., 3½ mi. SW Jefferson, TD 7,502 ft., elev. 216 ft., Travis Peak 6,084 ft., Paluxy 4,047 ft., dual completion, perforated Hill zone 6,080-97 ft., IP 8,150,000 cu. ft. gas, plus 120 bbl. distillate; perforated Henderson zone 5,956-70 ft., IP 1,080,000 cu. ft. gas, plus 13 bbl. distillate, ¼-in. chokes.

EAST TEXAS (DISTRICTS 5 AND 6) WILDCAT FAILURES

Grayson County: Edwin L. Cox 1 Laura Newton, J. Murphy Sur., A-789, dry, TD 8,072 ft.

Kaufman County: American Liberty Oil Co. 1 Travis Piper, R. C. Dixon Sur., dry, TD 6,433 ft., Woodbine 3,100 ft.

McLennan County: Max McCotter 1 E. J. & L. D. Wardlow, I, Garlindo Sur., dry, TD 1,322 ft.

Smith County: Union Oil Co. of California 1 J. L. Morrison, S. J. Lott Sur., dry, TD 8,067 ft., Paluxy 5,390 ft., Glen Rose 5,712 ft.

Wood County: Trans-Texas Drilling Co. 1 A. W. Rutter, H. Payne Sur., dry, TD 6,003 ft.

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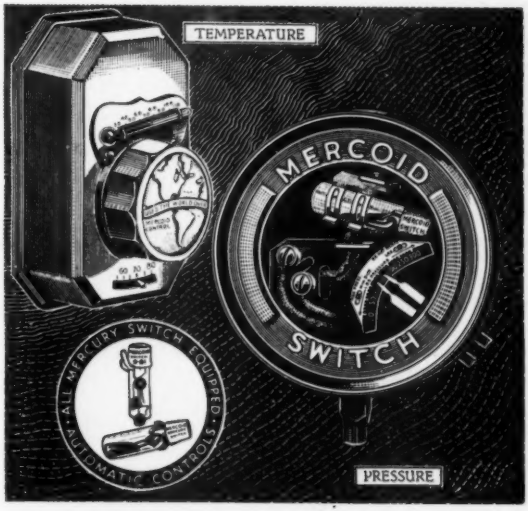

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Texas Gulf Coast

Potential Test Run at Brazoria County Discovery

HOUSTON.—Potential test has been run at The Texas Co. 1 John W. Harris et al, oil discovery located 1¼ miles southeast of Chocolate Bayou field in Brazoria County. From perforations at 10,610-17 ft., the well flowed 213 bbl. of 38.7°-gravity oil under tubing pressure of 450 psi. New discovery is located in Asa Brigham survey, Abstract 47.

Three miles south of Livingston field in Polk County, Jordan Drilling Co. and Kraftex Enterprises, Ltd., have potentialed 1 Mrs. Pearl Wiggins for 174 bbl. of oil daily. Production is through perforations in the Wilcox at 7,841-53 ft. and flow was gaged through ¼-in. choke. Tubing pressure registered 1,850 psi. and casing pressure 2,410 psi. New discovery is located in G. S. Thomas survey, Abstract 72.

Sohio Petroleum Co. has recompleted 1 B. E. Quinn in a new oil pay after squeezing off perforations in a gas-distillate sand. This well, located in James Humphreys survey, Abstract 212, 8 miles south of Cleveland in Liberty County, was completed last year for 23,000,000 cu. ft. of gas daily plus 52.4°-gravity distillate from perforations at 7,170-75 ft. These perforations were squeezed and operator reperforated at 7,370-73 ft. This new sand produced 92 bbl. of 36.8°-gravity oil daily through 10/64-in. choke under tubing pressure of 200 psi.

A new gas-condensate discovery is completing at Robert Mosbacher 1 D. Nebbe, wildcat in Colorado County 1½ miles west of Inglehart field. After acidizing perforations at 8,810-15 ft. with 1,000 gal., the well flowed an ungaged amount of gas and distillate through ¼-in. choke under tubing pressure of 1,400 psi. Previous tests at 8,770-85 ft., and 8,787-8,800 ft. showed gas.

Humble Oil & Refining Co. has logged approximately 100 ft. of possible oil sand in 1-C William Rice Institute, Tyler County wildcat located 2 miles west of East Hillister field. Sand was logged between 4,600 and 4,900 ft., with one section being 38 ft. thick. Operator is drilling below 6,995 ft. on a 10,600-ft. contract.

New pay has been opened in Muldoon field, Fayette County, at Hammon Oil & Refining Co. 3 Joseph Tupa et al, from open hole at 2,326-33 ft., the well flowed 107 bbl. of 21°-gravity oil daily through 13/64-in. choke. Well is located in John Vivien 1/3 League.

TEXAS GULF COAST (DISTRICTS 2 AND 3) SUCCESSFUL WILDCATS

Jackson County: Oil discovery—J. M. Flaitz 1 John M. Bennett, V. Garcia Sur. A-24, TD 6,354 ft., perf. 6,181-85 ft., IP 178 bbl. oil per day, 10/64-in. choke, 41°-gravity, TP 1,700 psi.

Polk County: Oil discovery—Shell Oil Co. 1 Kirby Lumber Co., Tract 125-A, James Stephenson Sur. A-523, TD 7,002 ft., perf. 5,322-40 ft., IP 48 bbl. oil per day, ⅛-in. choke, 44.6°-gravity.

TEXAS GULF COAST (DISTRICTS 2 AND 3) WILDCAT FAILURES

Chambers County: Production Service Oil Corp. et al 1 E. C. Moor, Vincent Barrow Sur. A-39, dry, TD 7,502 ft.

DeWitt County: Arkansas Fuel Oil Co. et al 1 Alfred Friar, T & N O RR Sur. A-571, dry, TD 9,190 ft.

Columbia Drilling Co. 1 D. H. Heaton et al Manuel Manchaca Sur., dry, TD 8,025 ft.

Fayette County: M. F. Mitchell 1 McAnnally et al Almon Weaver Sur., dry, TD 2,470 ft.

Karnes County: Sunray Oil Corp. 1 Karon McSmith, Ramon Musquiz, A-8, dry, TD 4,500 ft.

Montgomery County: Moran Corp. et al 3-A Hutchings-Sealy National Bank, J. C. Pitts Sur. A-28, dry, TD 12,060 ft.

Refugio County: Remar Oil Co. 1 Landgraf, G. C. Hatch Sur. A-166, dry, TD 8,715 ft.

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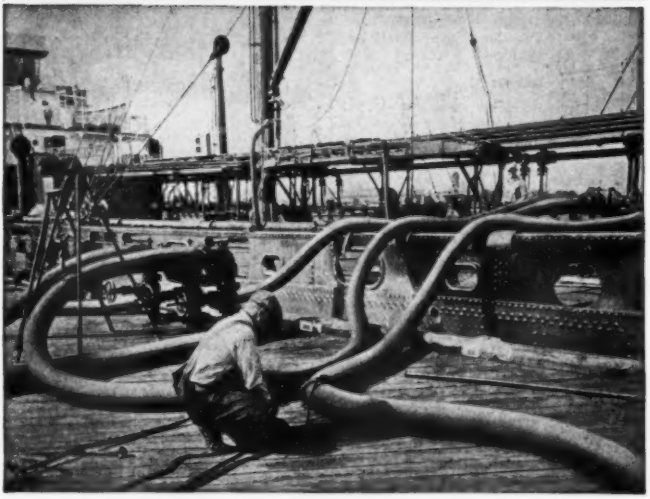

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North Central Texas

Operators Drilling Ahead At Cooke County Wildcat

WICHITA FALLS.—Continental Oil Co. 1 H. M. Berry, Cooke County wildcat 5 miles north of Roston, recovered 123 ft. of heavily oil-cut mud on a 30-minute drill-stem test at 5,404-14 ft. Operators were drilling ahead at 5,415 ft., in granite wash.

In Montague County, J. B. Revier 1 Mrs. L. A. McNabb, 4 miles southeast of Nocona, was to be a dual completion from the upper Caddo conglomerate and lower Bend conglomerate. Flow tests gaged 90 bbl. of oil in 6 hours through 20/64-in. choke from the Caddo and 126 bbl. of oil in 6 hours, same choke, from the Bend. Flowing tubing pressure was 438 and 600 psi., respectively.

Texas Pacific Coal and Oil Co. and others made location for 1 T. F. Welch as a 6,500-ft. wildcat about 1½ miles north of Foard City, Foard County. Location is in the Nelson Box Survey.

Deep drilling was slated for Wichita County at Akin & Dimock 1 S. P. Cunningham, 5 miles southwest of Wichita Falls in 1-A58-Denton CSL.

In Throckmorton County, Noel Pautsky 1 T. W. Massey, 5 miles south of Throckmorton, gaged 78 bbl. of 42°-gravity oil a day through ½-in. choke from pay at 4,151-61 ft.

Twelve miles southwest of Throckmorton, Cabot Carbon Co. 1 John T. Davis was drilling ahead below 4,558 ft. after testing shows of oil and gas. At 4,508-15 ft. developed 10 ft. of oil and 40 ft. of heavily oil-cut mud in 65 minutes. Second test from 4,424-39 ft. was said to have recovered oil, or oil-cut mud, but details were lacking. Third test at 4,508-15 ft., open 75 minutes, recovered 30 ft. of heavily oil-cut mud.

In Clay County, Bridwell Oil Co. 19 Bridwell River Ranch, 3½ miles west of Halsell, developed 185 ft. of clean oil and 35 ft. of mud on a test in the Caddo at 5,343-55 ft. Previous oil shows were reported at 4,716-30 and 4,738-52 ft. Recovery at 4,738-52 ft. was 3,500 ft. of oil in 32 minutes. Operators were drilling ahead.

NORTH CENTRAL TEXAS (DISTRICTS 9 AND 7-B) SUCCESSFUL WILDCATS

Brown County: J. R. Lind 1 A. F. Armstrong, H&GN Sur., 2 mi. NE Cross Cut, TD 1,425 ft., sand pay 1,406 ft., IP pumped 3 bbl. 42°-gravity oil.

Coleman County: A. M. Howsley 1 Duncan heirs, Sec. 12, T&NO Sur., TD 3,491 ft., elev. 2,111 ft., sand pay 3,474-88 ft., IP 254 bbl. 43°-gravity oil, 14/64-in. choke, TP 325 psi.

A. M. Howsley 2 C. F. Sappington, Sec. 12, T&NO Sur., TD 3,460 ft., pay 3,404-18 ft., IP 156 bbl. 43°-gravity oil, ¼-in. choke, TP 375 psi., GOR 400 cu. ft.

Tri-M Production Co. and Morris Mizel 1-G Mrs. Mary Dunman, Sec. 35, T&NO, TD 3,133 ft., elev. 1,798 ft., Morris sand 3,121 ft., IP 356 bbl. 42°-gravity oil, 10/64-in. choke, TP 290 psi., GOR 1,600 cu. ft.

Jack County: E. A. Karper 1 Sheril Raley, W. Hill Sur., A-1964, TD 2,364 ft., pay 2,331 ft., IP pumped 21 bbl. 42°-gravity oil.

Jones County: Robinson-Puckett, Inc. et al 1 W. M. Chambers, 15-1-T&NO, TD 2,342 ft., elev. 1,697 ft., Flippen pay 2,330 ft., IP pumped 122 bbl. 39°-gravity oil.

Sojourner Drilling Co. 1 H. L. Osment, 33-1-BBB&C, TD 2,641 ft., elev. 1,617 ft., pay 2,631 ft., IP 123 bbl. oil, 20/64-in. choke, TP 70 psi.

Montague County: Luke Grace Drilling Co. 1 T. H. Milam, Sec. 54, Abel Deason Sur., TD 5,654 ft., Caddo 5,605 ft., pay 5,635 ft., IP 198 bbl. 43°-gravity oil, 12/64-in. choke, TP 650 psi., GOR 575 cu. ft.

Warren C. Northcutt 1 Jess Sanders, Blk. 114, J. C. Mattison Sur., TD 6,150 ft.,

perforated Caddo 5,855-79 ft., IP 232 bbl. 40°-gravity oil, ¼-in. choke, TP 450 psi., GOR 553 cu. ft.

Nolan County: Mar-Tex Realization Corp. 1 Boothe, 76-22-T&P, TD 5,215 ft., elev. 2,212 ft., perforated Canyon sand 5,206-15 ft., IP 152 bbl. 40°-gravity oil, 20/64-in. choke, TP 60 psi., GOR 640 cu. ft.

Stephens County: Connally & Jackson 1 Ross Greenlee, Sec. 5, BAL Sur., TD 2,424 ft., pay 2,205 ft., IP pumped 32.4 bbl. 37°-gravity oil.

Wichita County: Consolidated Oil Co. 1 Francis Dickinson, Blk. 3, Westmoreland Addition, TD 4,373 ft., pay 1,281 ft., IP pumped 52.6 bbl. 40°-gravity oil.

Alexander Goldsmith 1 Mrs. Pearl Boyd, Blk. 50, Kemps Wichita Valley Farm Lands, TD 3,930 ft., KMA sand pay 3,906-31 ft., IP 223 bbl. 42°-gravity oil, 16/64-in. choke, TP 110 psi., GOR 500 cu. ft.

Wilbarger County: Baker Properties 1 W. T. Waggoner "Lakeview," Sec. 5, H&TC, TD 1,962 ft., pay 1,940 ft., IP pumped 15 bbl. 38°-gravity oil.

Young County: R. W. Darden 2 Couper & Seibold, Blk. 81, TE&L Sur., TD 1,187 ft., pay 1,185 ft., IP pumped 37 bbl. 39°-gravity oil.

R. W. Darden 4 Couper, Sec. 81, TE&L, TD 1,181 ft., pay 1,179 ft., IP pumped 61 bbl. oil

NORTH CENTRAL TEXAS (DISTRICTS 9 AND 7-B) WILDCAT FAILURES

Archer County: Bridwell Oil Co. 1 Otto Anderle, Blk. 3, Clark & Plumb, TD 4,845 ft.

L. T. Burns, 1 E. S. Carter, Blk. 96 ATNCL, dry, TD 5,304 ft.

Fortex Oil Corp. 1 J. H. Turbeville, Jefferson CSL, dry, TD 1,116 ft., Gunsite 1,018-20 ft.

Gilchrist & Langford 1 J. Penartz, Blk 4, Clark & Plumb, dry, TD 1-100 ft.

Brown County: B. F. Thomas 1 J. C. Bowden, A. White Sur. 161, dry, TD 2,036 ft.

Callahan County: Signal Oil & Gas Co. 1 Mrs. W. L. Henry, 155-2-GH&H, dry, TD 4,100 ft., elev. 1,850 ft., Morris 2,632 ft., Gardner 3,052 ft., Mississippian 4,088 ft.

Clay County: W. H. Hammon 1 Sanford Ballou, Sec. 55, HT&B, dry, TD 6,141 ft.

Frank Wood 1 Frank Wolf, Blk. 3, Specht & McCutchens Subd., dry, TD 2,002 ft.

Coleman County: L. H. Choate & Bankline Oil Co., 1-25 Ballard, 25-2-GH&H, dry, TD 3,150 ft., elev. 1,784 ft., Gardner 2,645 ft., Caddo 3,047 ft.

Fleet Drilling Co. 1 W. H. Finley, Sec. 10, T&NO, dry, TD 3,658 ft.

Richard King 1 C. Wilson, Sec. 12, T&NO, dry, TD 3,556 ft., elev. 2,037 ft., reef 3,490 ft.

Hal F. Rachal 1 Stearns, Sec. 79, J. L. Tindell Sur., dry, TD 975 ft.

Cooke County: Elm Oil Co. 1 Fields & Bowers, L. Ramey Sur., dry, TD 3,539 ft.

David Wimbell 1 J. W. & G. L. Alexander, Harriet Nail Sur., A-790, dry, TD 1,305 ft.

Eastland County: Star Oil Co. 1-B S. A. Huestis, Sec. 8, BBB&C Sur., dry, TD 4,247 ft., elev. 1,703 ft., Caddo 3,196 ft., Mississippian 4,130 ft., Ellenburger 4,487 ft.

Haskell County: Skelly Oil Co. 1 Myrtle Beason, 194-45-H&TC, dry, TD 6,037 ft., elev. 1,553 ft., Caddo 5,507 ft., Mississippian 5,775 ft.

Jack County: Bilberry & Albritton 1-A Singleton, M. Rockerfellow Sur., dry, TD 782 ft.

G. W. Cooper 1-B Cherryhomes, T. Burbridge Sur., A-68, dry, TD 4,706 ft.

Warren Oil Corp. 2 W. E. Ruth, Sec. 1, SPRR Sur., dry, TD 2,450 ft.

Jones County: Ungren & Frazier 1 Elmer Holland, Sec. 195, G. Martinez Sur., dry, TD 2,825 ft., Gunsite 2,250 ft.

Montague County: D. H. Bolin 1 C. R. Tucker, C. Nichols Sur., dry, TD 2,105 ft.

S. D. Johnson 2 Doug Johnson, T. F. Morrow Sur., dry, TD 3,203 ft.

Shackelford County: H. J. Anderson 2 D. O. Anderson, Sec. 3, LAL Sur., dry, TD 648 ft.

Sadler & Boyd 2 Dick Shelton, Sec. 573, TE&L, dry, TD 341 ft.

Stephens County: Bay Petroleum Co. 1 L. G. Ledbetter, 28-6-T&P, dry, TD 3,703 ft., elev. 1,526 ft., Caddo 3,260 ft.

Pauley-Bond 1 Freeman-Williams, 32-5-T&P, dry, TD 2,220 ft.

Taylor County: Carl Hovgard 1 Mrs. Goldie Malone, 1-18-T&P, dry, TD 3,675 ft., elev. 1,955 ft., reef 3,592 ft.

Wilbarger County: John & Pat O'Neil 1-I W. T. Waggoner, J. Poitevant Sur., dry, TD 2,200 ft.

Young County: S. R. Baker 1 Mrs. L. H. Yates, Sec. 276, TE&L, dry, TD 4,251 ft., KMA 2,585 ft., Caddo 3,957 ft.

R. W. Darden 3 Couper & Seibold, Blk. 81, TE&L, dry, TD 1,202 ft.

R. W. Darden 1 Mrs. C. H. Crouch, E. W. Sargent Sur., dry, TD 564 ft.

E. H. Remington 1 C. J. Taack, TE&L Sur., dry, TD 674 ft.

Canadian Fields

Canadian Discoveries Set Record Pace

CALGARY.—Oil and gas discoveries have been made in western Canada at the rate of one every 3 days since the beginning of 1952. In addition to this record rate of discovery, other exploratory ventures, drilling in extension areas of previously discovered oil or gas pools have also indicated success in substantial numbers.

Of the 21 exploratory wells that indicated discovery of oil or gas, 11 found oil and 10 struck natural gas or "wet gas" in volumes that appear to be commercial.

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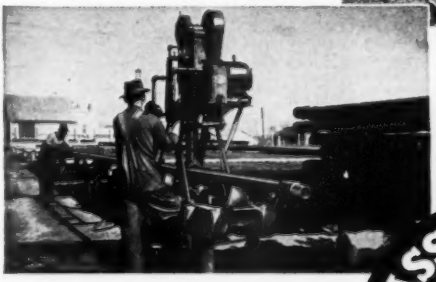

(*Left*) Returned pipe is straightened, repaired to first class condition and threads properly lubricated before being replaced on racks.

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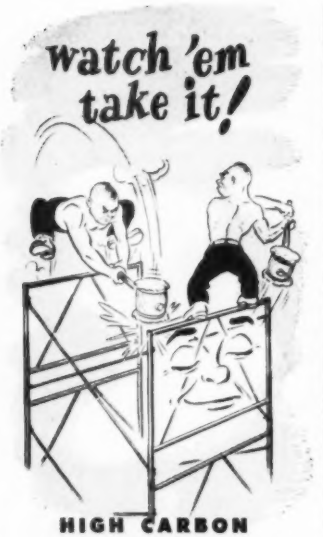

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Two extension wells, about 1 mile from previous production found commercial oil, while five wells ranging from 2 to 6½ miles from previous gas wells gave up substantial volumes of natural gas during tests.

Alberta, the nation's oil and gas province yielded the greatest percentage of the new 1952 finds, while Saskatchewan and British Columbia also came through with discoveries and or extensions.

Ten of the eleven new indicated oil discoveries were made in Alberta, while Saskatchewan gave up its first medium gravity oil this year. Alberta's 1952 gas discoveries number nine to date, while Saskatchewan has shown one gas discovery. The two oil extensions were made in Alberta, and that province also accounted for two gas extensions. The northeast area of British Columbia has rated two natural-gas extensions and Saskatchewan has accounted for gas extensions in one area.

One of the most promising oil discoveries so far this year was made at Bonnie Glen, where over 600 ft. of D3 oil-bearing Devonian reef has been encountered. The discovery well went on steady production earlier this year, and three follow-up drillers are now under way in that region, by Texaco Exploration Co. and McColl-Frontenac Oil Co., discoverers of the Bonnie Glen oil. This project is located some 6½ miles south of Wizard Lake producers, and is a discovery of indicated major proportions.

In the Malmo area, a few miles southwest of New Norway oil pool, the team of Scurry-Central Explorers-Dragon Oils-Canadian Fina discovered oil in both the D2 and D3 zones of Devonian. That well has been placed on steady production, the first offset driller has so far encountered oil in the D2 and is now heading for its D3 objective. A third well, offsetting the discovery to the northeast, is also being started by the team of Sun Oil and McCarty & Coleman.

Socony - Vacuum, Anglo-Canadian, Calmont and Kroy Oils share a Devonian oil discovery well which is located in the Twining-Three Hills area, about 45 miles northeast of Calgary. During initial production tests this strike gave up crude oil at the rate of 100 bbl. daily. Further testing operations will be carried out at this strike in an effort to fully evaluate the discovery.

About 2 miles south of the main producing sector of Stettler oil field, Canadian Gulf discovered another D3 oil pool, during the early part of January. This South Stettler strike went on production after finding a thin D3 oil productive section.

In the southern sector of Leduc Devonian oil pool, New Continental Oil Co. of Canada, Ltd., struck a flow of oil from the D3 zone, in an area that had previously yielded only D2 oil production. Further offset drilling in that region will be carried out by New Continental to determine the extent of this indicated new D3 oil pool.

Other Alberta ventures that indicated oil discovery, but that have not as yet been fully tested to determine whether they will produce in commercial volume include: the Albermont - Mill City - Leduc Consolidated's Duhamel area well which struck some oil and gas plus salt water in the Lower Cretaceous (well later found commercial production in the D2 zone of Devonian); the Ajax Petroleum's well in the Sturgeon area of Campbell which found some oil and gas in the Cretaceous; a wildcat in the Chinook Valley area of the Peace River region which found oil, gas and water in the Triassic; the Manawan Lake area driller which discovered a thin Viking oil section; an indicated discovery 2 miles south of Bashaw D3 oil wells.

In the Fosterton area of Saskatchewan, around 27 miles northwest of Swift Current, Socony-Vacuum Exploration Co. made Saskatchewan's 1952 oil discovery, the province's first medium gravity crude-oil producer. On potential test the well flowed at rate around 300 bbl. daily. First follow-up driller was abandoned, and the com-

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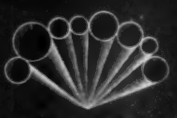

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pany's second extension test well is now under way.

One of western Canada's most significant gas strikes so far this year was made by Canadian Delhi Oil, Ltd., on farmout lands from Britalta Petroleums, Ltd., in the Winchell Coulee area of the Alberta foothills. That venture found its gas in the Cardium sand formation during drill-stem test this week, and flowed at rate around 3,000,000 cu. ft. daily, with indicated high formation pressures. Distillate also sprayed to the surface during initial drill-stem test and there was a fluid recovery of 130 ft. of distillate which has estimated gravity in excess of 55°. Crew was continuing coring and testing at last report, in search of an oil column which may or may not exist below. Company engineers estimated flow potential at this well at around 10,000,000 cu. ft. daily on the basis of first test.

In the Nevis area, around 7 miles west of Stettler Devonian oil wells, Canadian Gulf Oil Co. discovered a flow of natural gas plus some condensate at a wildcat driller. This strike was made in the D2 zone of Devonian and yielded natural gas at rates up to 8,000,000 cu. ft. daily. The D2 has been fully penetrated, and well is now being deepened in search of the D3 horizon.

In the North Bashaw area, the team of Trans Empire-Hy Charger-Pacific-Sharples struck a moderate flow of natural gas in the Lower Cretaceous, while heading for the exploratory well's Devonian objectives. The British American Oil Co. discovered gas at its offset venture to the Clive D2 oil discovery well which was drilled last year. This venture found its gas in the Viking sand and Cretaceous, while the oil discovery well last year found only the Cretaceous gas productive.

Other Alberta gas strikes so far this year were made at Dunvegan, in the Gething-Cadomin; at Beaverhill Lake, in the Viking; at Bullpound, in the Viking; at Millet, in the Viking; and an indicated discovery in the North Brazeau area.

In the Elrose area of southern Saskatchewan, the Sohio Petroleum Co. group found natural gas. That venture, located around 90 miles southwest of Saskatoon, gave up Viking sand gas at rate around 7,000,000 cu. ft. daily during drill-stem test.

The two oil extensions made in Alberta so far this year are in the Camrose Viking sand oil area, while the gas extensions were both in the Lac la Biche area of northeast Alberta. In British Columbia, two exploratory ventures in the Fort St. John area found natural gas in substantial volume in several formations. The natural gas extensions in Saskatchewan were in the Brock area.

CANADIAN SUCCESSFUL WILDCAT

Bay 4-1 Hanna, LSD 4, 1-31-16w4, TD 5,903 ft., IP 6,300 M.c.f. natural gas daily.

CANADIAN WILDCAT FAILURES

Pan Western-Long Island 1 Glendon, LSD 9, 24-61-9w4, TD 1,617 ft.

Imperial 12-2 Golden Hill, LSD 12, 2-30-16w4, TD 6,318 ft.

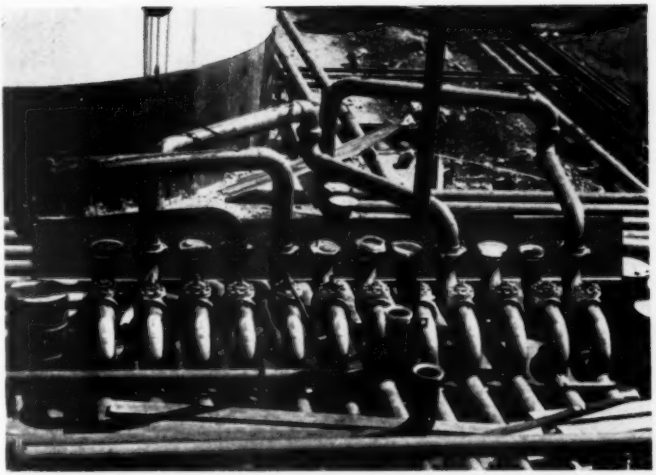
Imperial 2-12-51 Gramina, LSD 2, 12-51-27w4, TD 6,500 ft.

Imperial 7-5-82 Harmon Valley, LSD 7, 5-82-18w5, TD 7,294 ft.

Imperial 4-27-86 Hines Creek, LSD 4, 27-86-2w6, TD 8,750 ft.

EASTERN CANADA

In southwestern Ontario, Anchor Petroleums, Ltd., and Western Ashley Minerals, Ltd., both interested in Alberta oil production, are jointly undertaking a systematic exploration program involving acreage extending from just west of London through the Wardsville area to Port Lambton on the Detroit River. Extensive leases have been taken in eight main areas, some of them adjacent to existing oil and gas production or to recent discoveries. Much of the acreage lies on a potential northerly extension of the Cincinnati arch, which is



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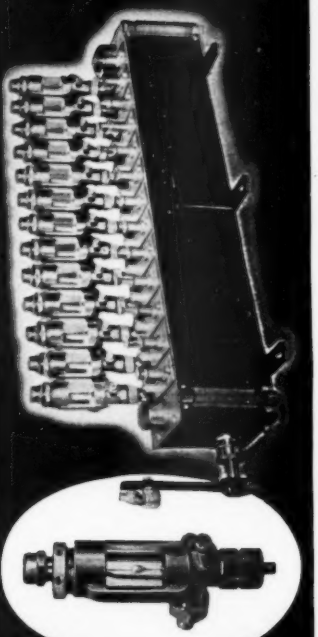

LUBRICATOR DIVISION

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the principal structural feature of a number of oil fields in the eastern states and as far west as Ohio, Illinois, and Indiana.

Within recent years, new oil or gas discoveries have been made in Sombra and Moore townships, Lambton County, and in the Wardsville area in Middlesex with some shallow oil near Rodney in Elgin County. Except for a few isolated exploratory wells, large intervening areas have never been tested. Potential formations include the Delaware and Onondaga at 350-500 ft., the Salina and Guelph-Niagara around 1,300-1,400 ft. and the Trenton limestone around 3,000 ft. These depths are much less than in the Alberta fields. It is planning to start drilling operations this spring.

In Bruce County, interests associated with the Sun Oil Co. have secured acreage in Huron Township, south of Kincardine, mainly between Concessions 8 and 10 and Sideroads 20 and 25, with a view to drilling this spring.

LOUISIANA WILDCAT FAILURES

Concordia Parish: Magnolia Petroleum Co. et al 1 Madison O&D Co., 660 ft. S and 4,585 ft. E NWc 39-8n-9e, dry, TD 7,909 ft.

Sabine Parish: E. M. Compton et al 1 Long Bell Lumber Co., 701 ft. N and 760 ft. W. SEc 15-7n-13w, dry, TD 7,509 ft.

Louisiana-Arkansas

Fourth New Field of Year Seen For North Louisiana

SHREVEPORT.—Pan-Am Southern Corp. has completed 1 Advance Bag & Paper Co., 17-17n-6w, Bienville Parish wildcat, 3½ miles northwest of Bear Creek field. An open flow from curve of 10,000 M.c.f. of gas daily was reported from perforations at 6,917-24 ft. in Travis Peak. Total depth is 8,025 ft.

It appears that a large syncline exists between Bear Creek field and the new discovery. The new discovery will probably be called a new pool rather than an extension of Bear Creek. Several dry holes have been drilled between the two areas in the past.

If the new discovery is designated a new field it will be the fourth new area for northern Louisiana this year. Helena, Rockpoint, and Springhill were new oil fields, while the Bienville discovery will mark the first new gas field of the year.

The new Springhill field in Webster Parish has announced the first official completion at Crow Drilling Co. 1 Thomas J. Harrison, 6-23n-10w. The well flowed 19.7 bbl. of 40.9°-gravity oil hourly on state gage. After the state test the well was put on ¼-in. choke, flowing at the rate of 12 bbl. hourly. Completion was made from open hole below pipe set to 3,101 ft. in the Tokio sand.

The L. L. Robinson 1 Kilpatrick was unofficially completed previously for 6-8 bbl. of oil hourly from the Tokio. The discovery well for Springhill field is awaiting official state test, and will be designated as the discovery well when officially completed. Also due for early completion is Robinson et al 2 Kilpatrick. Perforations have been made at 3,113-3,120 ft. in the Tokio.

McGalman-Gunn Drilling Co. has asked permission to abandon 1 Jesse L. Boucher, 2-23n-11w, 1,000 ft. north of Springhill town, at the depth of 3,126 ft. Crow Drilling Co. has staked 1 Browning, 6-23n-10w, as an offset to the just completed 1 Harrison. A total of 13 locations have been staked on the Louisiana side of the new field.

Shell Oil Co. 2 Browning-Burns unit, Columbia County, Arkansas wildcat, is reported to be drilling below 2,000 ft. on the Arkansas side of Springhill field. The Arkansas Oil and Gas Commission has officially designated the new Tokio play area near Springhill as the Springhill field.

LOUISIANA SUCCESSFUL WILDCAT

Webster Parish: Carter Oil Co. 1 Davis, C SW SE 27-18n-8w, flowed 140 bbl. 22.3°-gravity oil from Morringsport 4,386-4,402 ft., TD 4,445 ft. PBTD 4,414 ft. (New pay in Ada pool).

Appalachian-Ohio

Two Good Gas Wells Reported in West Virginia

PITTSBURGH.—Kermit district, Mingo County, West Virginia, United Fuel Gas Co. 6831 Cotiga Development Co., resulted in 1,138,000 cu. ft. gas in the Brown shale, total depth 3,734 ft. Big Creek district, McDowell County, Godfrey L. Cabot, Inc., gaged 1,107,000 cu. ft. gas, Berea sand, total depth 4,359 ft. Williamsburg district, Greenbrier County, Deep Rock Oil Corp. 1 Bertha H. Thornbury et al, elevation 2,420 ft., after fishing operations, is now drilling at 4,005 ft. Portland district, Preston County, Hope Natural Gas Co. 9673 Nina Kay, elevation 2,296 ft., is drilling at 5,550 ft. The 9676 Sarah J. Creamer, elevation 2,097 ft., is drilling at 5,300 ft. Oriskany sand 5,243 ft. gas testing 309,000 cu. ft. at 5,244-5,255 ft. The 9694 Leona Burrows, elevation 2,061 ft., is drilling at 5,336 ft. Oriskany sand 5,273 ft. gas testing 96,000 cu. ft. at 5,274-5,276 ft. Manufacturers Light & Heat Co. 4116 Enzer & Annie E. Whitehair, elevation 2,209 ft., is running casing at 5,318 ft. Union district, Pendleton County, Seneca Gas & Oil Co. 1 Neil Harper, elevation 2,248 ft., is drilling at 1,800 ft. Jumping Branch district, Summers County, United

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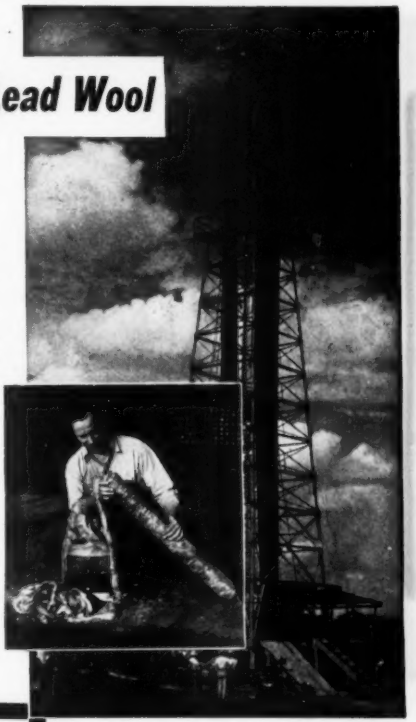

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Fuel Gas Co. 6788 J. Santord Willy, elevation 2,613 ft., is drilling at 1,125 ft.

Pennsylvania.—Unity Township, Westmoreland County: Peoples Natural Gas Co. 4003 A. J. Dotterway, elevation 2,094 ft., is drilling at 6,200 ft.

Maryland.—Garrett County: No completions were reported, nor were any important horizons noted in wells under way. A major number of wells are reported as being shut down.

OHIO

The Mid East Oil 1 Bertha Hayes, Section 18, Jackson Township, Knox County, 1/3 mile southwest of the 1 Lee Dugan, made 10 bbl. natural and 150 bbl. in 24 hours after a 150 qt. shot. Clinton sand was logged at 2,898-2,955 ft. It is probable that several additional wells will be started, and that a fair sized oil pool will be developed.

The Preston Oil extended the New Castle pool in Coshocton County a location to the east. Their 1 R. J. Daliere, Section 23 with Clinton at 3,332-57 ft., made 53 bbl. in 40 hours natural, and swabbed 125 bbl. in 24 hours after a 60 qt. shot. In the northeast extension to the same pool the Preston Oil 1 Chas. Heffelfinger, 3rd Qr., found sand at 3,367-3,432 ft. with 60 bbl. natural. The well was shot with 120 qt. and swabbed 135 bbl. in 24 hours.

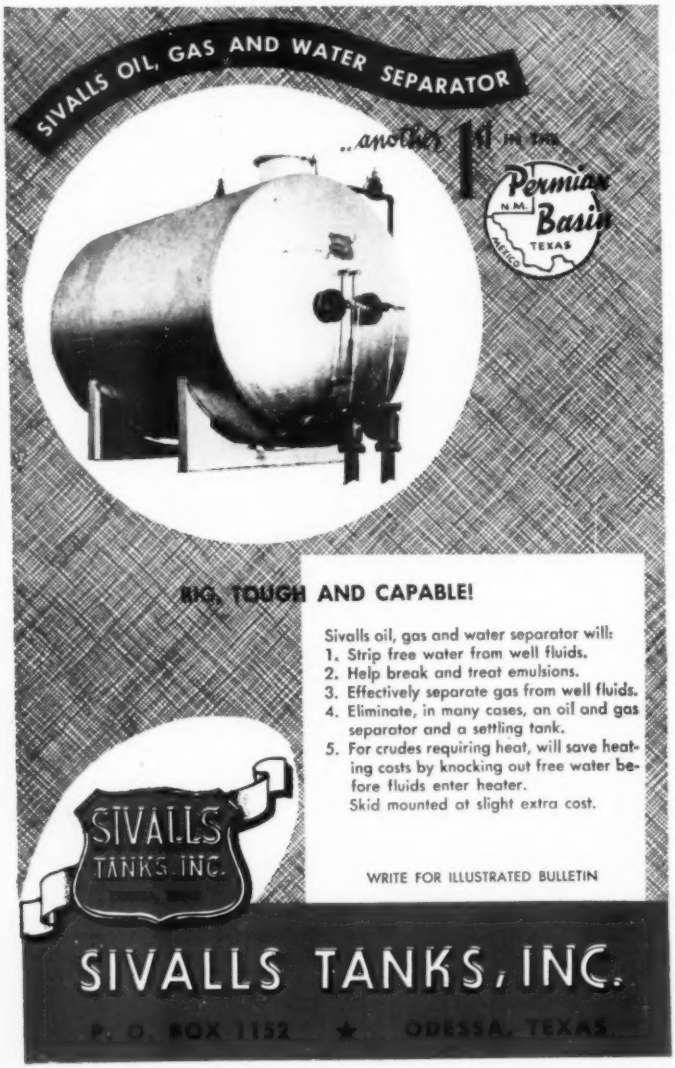
The Mid East Oil has started drilling on a wildcat in Decatur Township, Washington County, on the Nellie Riddle tract in Section 8.

OHIO WILDCAT FAILURES

Summit County, Boston Township: Wade Development 1 John Solpa, Lot 17, Clinton 3,618-3,663 ft., TD 3,695 ft.

Copley Township: Ed Obermiller et al 1 J. C. Bender, Lot 42, Clinton 3,684-3,752 ft., TD 3,774 ft.

Norton Township: H. A. Demsey et al 1 L. O. Bauer, Lot 18, Clinton 3,668-3,683 ft., TD 3,722 ft.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Permian Basin

McElroy Ranch Well Nears Completion as Producer

MIDLAND.—On the north side of the Wilshire-Ellenburger field, Sinclair Oil & Gas Co. 10 McElroy Ranch was nearing completion as a producer. First test on casing perforations from 12,361-461 ft. flowed 360 bbl. of load oil and 257 bbl. of new oil in 7 hours. Location is in 130-D-CCSD&RGNG.

In northwest Upton County, and south of the Peck field, Magnolia 2-A American Republics developed 120 ft. of gas-cut mud on a 90-minute drill-stem test from 10,010-102 ft. Operators were conditioning hole.

Anderson-Prichard and Greenbrier 1 Windham, 108-D-CCSD&RGNG, was swabbing on perforations at 10,284-94 ft., in the Pennsylvanian. Recovery was drilling fluid and some gas, with fluid level at 9,400 ft.

Gulf Oil Corp. 1-L McElroy Ranch, west offset to the 1 Windham, recovered 26 ft. of lime, shale and chert with no shows on a core at 10,490-516 ft.

In Val Verde County, Phillips Petroleum Co. 1 Delta-Wilson, wildcat 7 miles southwest of R. J. Caraway's 1 Guida Rose gas discovery, recovered water blanket and 450 ft. of mud with no shows on a 50-minute test at 13,845-880 ft. It was drilling ahead. Top of a limestone, believed to be the Pennsylvanian, was reported at 13,842 ft.

Location was staked for a 12,000-ft. Val Verde wildcat by Dan Auld, as the 1 C. B. Wardlaw and C. H. Whitehead. Location in 76-D-GC&SF is 20 miles southeast of the Vinegarone gas area and just north of the Edwards County line.

Southwest Natural Producing Co. 1 O. L. Greer-Carter, wildcat some 3 miles east of the Sugg area in northeast Reagan County, found salt water in the Ellenburger in drilling to 10,051 ft., then plugged back to 6,285 ft. to test the Spraberry. Drill-stem tests while drilling developed some free oil around 6,009-32 ft. Top on the Ellenburger was 9,610 ft., and minus 7,059 ft.

Honolulu Oil Co. 2 Herbert Cope, 28-A-H&TC, third Spraberry producer for Sterling County, prepared to complete from open hole at 5,050-5,120 ft., total depth.

Tide Water Associated Oil Co. 1 Bigby, NW NW 11-36-T3S-T&P, extended Spraberry production east of a small producing area in southwest Glasscock County, assigned to the Driver field. Daily potential was 438 bbl. of 37°-gravity oil, flowing through ½-in. choke on perforations at 6,666-7,008 ft.

The two Pembrook fields of Upton County were closer together this week at the completion of Snowden and Ralph Pembrook's 1-8 Doris Way, 8-N-HE&WT. Potential was 480 bbl. of oil a day through ½-in. choke, from pay between 7,156-7,212 ft.

In northwest Schleicher County, Humble Oil & Refining Co. 1 R. L. Henderson developed 1,868 ft. of clean oil, plus 340 ft. of heavily oil and gas-cut mud on a 90-minute test at 5,496-5,516 ft. in the Wolfcamp limestone. Location is 1¼ miles southeast of Humble's 1 Pearl Williams, Strawn discovery in Irion County, and about 8 miles northwest of Pennsylvanian production in the Neva West field.

A record Spraberry producer was claimed by reports on Anderson-Prichard Oil Corp. 1 H. L. Hutt, 42-37-T3S-T&P, ¾-mile south extension well to the Tex-Harvey field of Midland County. Daily flowing potential was 877 bbl. of oil, through ¾-in. choke, from both the upper and lower Spraberry sands. Perforations were from 7,110-58, 7,195-7,215 ft., and 7,680-7,735 and 7,966-8,010 ft. Top of the Spraberry was 7,110 ft., minus 4,449 ft.

The Anadarko Basin received an 11,300-ft. Ellenburger wildcat test at Cities Service Oil Co. 1 Theis, in 177-2-I&GN, of western Roberts County. The drillsite was said to be

located on a block of 23,040 acres. It is 12½ miles northwest of Gulf Oil Corp. 1 John Haggard, also an Ellenburger test, which was trying to regain circulation around 4,500 ft.

WEST TEXAS (DISTRICTS 8 AND 7-C) SUCCESSFUL WILDCATS

Reagan County: L. B. Jackson 1 F. A. Bird, 33-C-L&SV, TD 7,710 ft., elev. 2,666 ft., Spraberry 6,702 ft., pay 6,750 ft., IP pumped 114 bbl. 37°-gravity oil.

Runnels County: G. B. Cree 1 C. E. McMillan, Sec. 2, A. Losoyo Sur. 515, TD 3,940 ft., perforated lower Fry 3,656-64 ft., IP 288 bbl. 44°-gravity oil, 20/64-in. choke, IP 435 psi., GOR 815 cu. ft.

WEST TEXAS (DISTRICTS 8 AND 7-C) WILDCAT FAILURES

Andrews County: Cities Service Oil Co. 1 Ogden, 15-A36-PSL, dry, TD 9,181 ft., elev. 3,113 ft., Grayburg 4,080 ft., Pennsylvanian 8,880 ft.

Gaines County: W. M. & A. P. Fuller 3 A. B. Wharton, Jr., 23-A21-PSL, dry, TD 4,820 ft., elev. 3,285 ft., San Andres 4,530 ft.

Kent County: Humble Oil & Refining Co. 1 L. R. Spires, 19-4-H&GN, dry, TD 7,575 ft., elev. 2,237 ft., Strawn 6,900 ft., Mississippian 7,525 ft.

Pecos County: Hunt Oil Co. 33 Elsinore, 25-C-GC&SF, dry, TD 1,088 ft.

Runnels County: Fox-Witherspoon Drilling Co. 1 Gerheart, J. S. Moore Sur. 36, dry, TD 4,256 ft., Serratt 2,252 ft.

Schleicher County: Frank & George Frankel 1 W. H. Williams, Sec. 27, HE&WT, dry, TD 7,370 ft., elev. 2,430 ft., Wolfcamp 5,485 ft., Strawn 7,261 ft., Ellenburger 7,340 ft.

Terry County: J. I. O'Neill, Jr. 1 J. L. Lyons, 10-C36-PSL, dry, TD 9,969 ft., elev. 3,273 ft., Dean 9,070 ft., reef 9,940 ft.

SOUTHEASTERN NEW MEXICO

Buffalo Oil Co.'s record well for the Permian basin, the 12-B Baish-Federal in 22-17s-32e, was having some water trouble and operators had injected gas as a flow stimulant. In 24 hours of testing through open 2-in. tubing, from open hole at 13,554-73 ft., the well flowed 332 bbl. of oil plus 86 bbl. of water.

A previous test gaged 375 bbl. of oil and 42 bbl. of water in 24 hours. The well has a very low gas-oil ratio, which was said to be characteristic of Devonian producers. Source of the water, which was only slightly salty, had not been determined.

Gardner Bros. Drilling Co., Dallas, drilled the deep discovery, which is in the old Maljamar field of Lea County.

Skelly Oil Co. 3-J Mexico-State, 32-24s-38e, north offset to the West Dollarhide Ellenburger discovery in Lea County, added Fusselman production to that area. Completion gage was 1,996 bbl. of oil a day through ¾-in. choke, from pay at 8,710-90 ft.

Another San Andres well has been added to southeast Roosevelt County. Austral Oil Exploration Co. 1 McGrail, 18-8s-38e, completed from open hole at 4,598-4,798 ft., for a daily potential of 104 bbl. of 26°-gravity oil.

The new well is about 2½ miles west of Shell Oil Co. 1 Pitman, San Andres discovery in Cochran County, Texas.

Lone Star Producing Co. has scheduled a 13,000-ft. or Devonian test 2½ miles northeast of the Crossroads field of Lea County. It is the 1 Warren-Davis, in 19-9s-37e. Location is on a farmout from King, Warren, Dye and Yeckel.

SOUTHEAST NEW MEXICO WILDCAT FAILURES

Chaves County: E. J. McCurdy 2 Key, 34-15s-29e, dry, TD 10,822 ft., elev. 3,814 ft., Pennsylvanian 7,800 ft., Mississippian 10,720 ft., tentative tops.

Lea County: The Texas Co. 1-AV State, 31-14s-32e, dry, TD 13,727 ft., elev. 4,349 ft., Wolfcamp 8,890 ft., Mississippian 12,600 ft., Devonian 13,300 ft.

California

California Drilling Is Up Despite Suspension Order

LOS ANGELES.—Despite the 30-day drilling holiday declared in the Wilmington field, drilling in California is on the increase. At the first of March operators had filed 448 notices to drill with the Division of Oil & Gas as compared with 380 in the same period a year ago. A total of 61 permits were filed last week, the largest weekly total filed thus far this year.

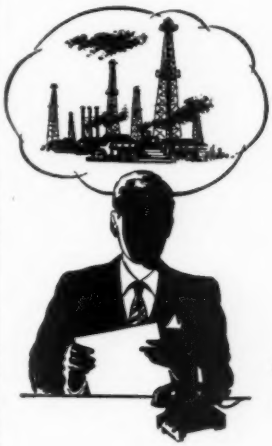
Development associated with 1951 oil discoveries accounts for a good portion of the activity but Ventura Avenue, with 20 rigs at work, remained the state's most active field. At Castaic Hills seven rigs were drilling, at Rosedale near Bakersfield, Humble Oil & Refining Co. had three wells under way; and at nearby Arvin five rigs were at work.

Resumption of development at South Mountain, near Ventura, is keeping a half-dozen rigs busy. Shell Oil Co., which last fall took over F. E. Fairfield's mountain-side properties, with four rigs at work is the field's most active operator.

A South Mountain development was the completion of a ¾-mile south extension by Ohio Oil Co. The extensioner, 1 Norman Richardson in NE SW 24-3n-21w, was completed as a 250-bbl. producer flowing through perforations at 5,373-6,241 ft.

Tulare County, which received no wildcatting activity during the first quarter, is in line for two new tests. About 4½ miles southeast of Visalia, in SE NE 14-19s-25e, Eureka Refining Co. was preparing to start 1 Eureka-Wright-Hart. Some 8 miles north of the town, E. C. von Glahn is to drill a 2,200-ft. wildcat in 24-17s-24e.

At the Kern River field near Bakersfield a deep test drilled by Independent Ex-



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ploration Co. failed to find production and has been plugged back for completion in the shallow Kern River sand. Located in 30-28s-28e, the test, 74 Bald Eagle, was drilled to 6,100 ft. after topping weathered granite at 6,038 ft. and hard granite at 6,085 ft. Formation tops released included the Vedder at 4,578 ft., lower Miocene silt at 5,505 ft., and Famosa sand at about 5,671 ft. Bald Eagle Oil Co. has taken over the well for shallow completion.

An agreement covering exploration, drilling and production on joint lands of Union Oil Co. and Brazos Oil & Gas Co. in Sacramento Valley has been announced. Union is named operator and the term of the agreement is 3 to 4 years. Brazos' present production at Isleton is excepted from the operation. The two companies currently have extensive acreage holdings in the valley, and seismic work is being conducted. It is expected that an active program of seismic work, leasing and drilling will be conducted.

Coastal California developments included the staking of two wildcats in the vicinity of San Ardo in Monterey County. Standard of California will attempt to extend Aurignac sand production about ½ mile east of the San Ardo field with its 14-5 Alexander-B in SW SW 5-23s-11e. In Peachtree Valley, about 17 miles north of the field, Union Oil Co. has staked location for its third test in that area. The new wildcat will be 3 Mee in SW NE 33-19s-10e.

The Morales Canyon area on the northwestern edge of Cuyama Valley, relatively quiet for the past year, shortly will receive a new wildcat. It will be North Basin Exploration Co. 1 Whitmey in SE NE 9-11n-28w, or about ¾ mile west of the Morales Canyon field. North of the proposed site ½ mile Pearson-Steffen drilled 1 Travers to 2,696 ft. without success while ¾ mile to the southeast General Petroleum Corp. drilled a 2,217-ft. dry hole. Objective of the new wildcat will be the Morales sand, found at depths of 1,700 to 2,000 ft. in the Morales Canyon field.

About 1 mile north of West Newport production in Orange County, Rancho Oil Co. was attempting to complete its 2-6 Walter Lamb in 60 ft. of oil sand topped at 5,790 ft. Drilled to 5,901 ft. with 5½-in. casing set at 5,780 ft., the wildcat was swabbing wash oil and water at last reports.

CALIFORNIA SUCCESSFUL WILDCATS

Los Angeles County, new deep-pool discovery in Seal Beach field: Continental Oil Co. 62 Bixby, SW SW 2-5s-12w, pumped 336 bbl. per day through perforations in Miocene sand at 7,995-10,870 ft., 38 per cent cut. TD 12,162 ft., elev. 15 ft.

Monterey County, ½ mile northeast extension to San Ardo field: Jergins Oil Co. 172-1 Orradre, NE SW 1-23s-10e, pumped 70 bbl. per day through perforations at 2,333-2,430 ft., 11°-gravity crude, 0.2 per cent cut. Lombardi 2,060 ft., Aurignac 2,333 ft., Basement 2,430 ft. TD 2,444 ft., elev. 596 ft.

Ventura County, ¾ mile south extension to South Mountain field: Ohio Oil Co. 1 Norman Richardson, NE SW 24-3n-21w, flowed 248 bbl. per day through perforations at 5,373-6,241 ft., 16.4°-gravity crude. TD 7,213 ft., elev. 2,240 ft.

CALIFORNIA WILDCAT FAILURES

Kern County, Bower Bank area: E. A. Bender 37-A KCL, 23-29s-24e, dry, TD 4,950 ft., elev. 299 ft.

Los Angeles County, Newhall-Placerita area: G. Dexter 1 Wegner, 36-4n-16w, dry, TD 1,683 ft., elev. 1,215 ft.

Monterey County, San Ardo area: Barnhart-Morrow Oil Cons. 1 Barnhart Morrow Lacoume, 13-22s-9e, dry, TD 1,360 ft.

Riverside County, Corona area: M. N. Hammerling 1 M.N.H., 21-4s-6w, dry, Granite 763 ft., TD 797 ft., elev. 1,150 ft.

San Luis Obispo County, Barret Creek area: The Texas Co. 2 Santa Margarita 2 (NCT-1), 26-31s-18e, dry, bottomed in granite. TD 808 ft., elev. 2,254 ft.

Santa Barbara County, Goleta area: Rothchild Oil Co. 1 Bishop, 7-4n-28w, dry, TD 3,963 ft.

Orcutt area: Union Oil Co. 13 Hartnell, 22-9n-34w, dry, TD 10,303 ft., elev. 610 ft.

Ventura County, Newhall - Potrero area: Newhall Land & Farming Co. 1 Co. Line, 32-4n-17w, dry, TD 10,798 ft., elev. 1,052 ft.

Red Mountain area: Amerada Pet. Corp. 1 H & S, 9-3n-24w, dry, TD 6,634 ft., elev. 502 ft.

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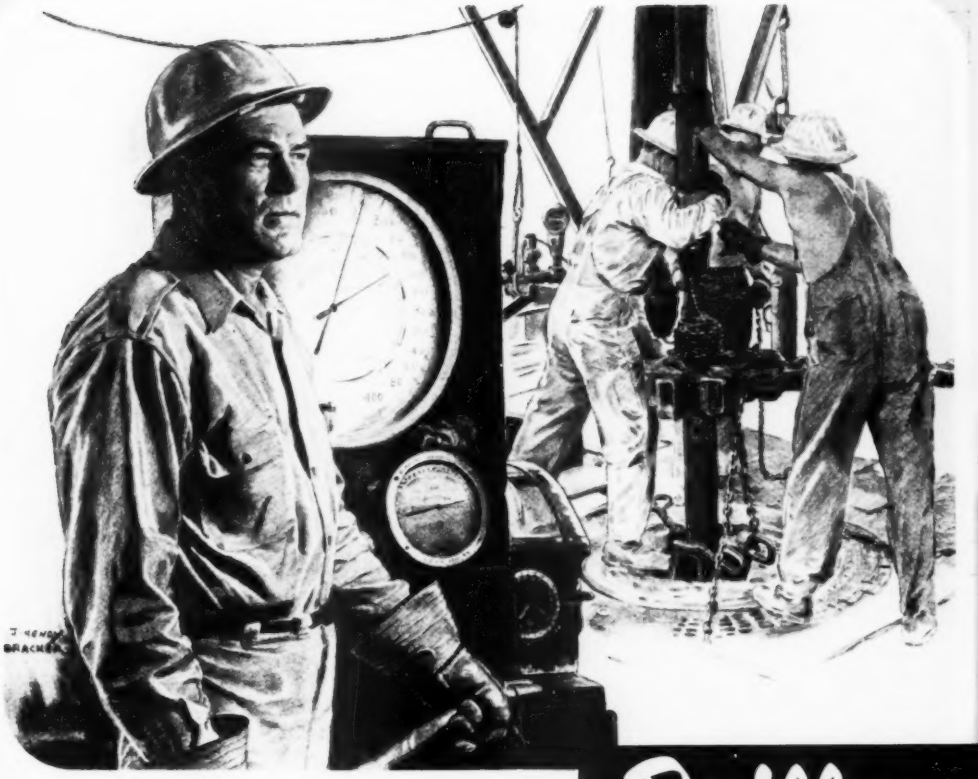

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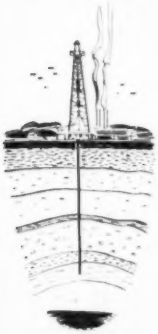

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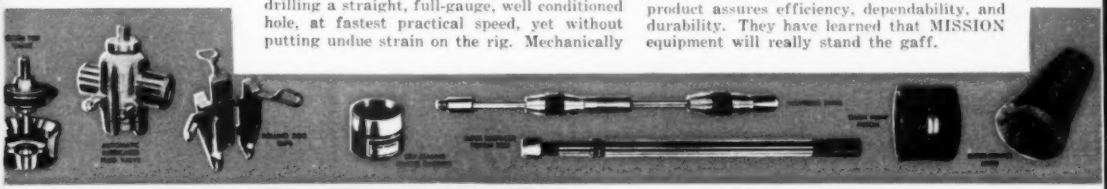

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Oklahoma

McClain County Wildcat Gets Bromide Oil Flow

DISCOVERY of another deep-producing field in McClain County is indicated by good oil showings encountered in the Bromide section by Woodward & Co. and Mendota Oil Co. at their 1 Conner, NE SE SW 11-7n-3w, 1½ miles north of Washington. Location is about 2 miles east of the deep Washington pool and about the same distance south of the deep Southwest Goldsby pool.

Bromide sand section was logged at 9,240-9,310 ft. with indicated pay zones at 9,233-9,300 ft. Drill-stem tests were made of three successive intervals, each getting flowing oil at estimated rates up to 85 bbl. per hour with no evidence of water. Operators are coring ahead for a look at possible lower productive zones.

Carter Oil Co. is opening a new Bromide reservoir off the east flank of the Southwest Antioch field in Garvin County, to the south, at its 1 Rosier-McCaskell, NW NW NE 28-3n-2w, where testing is under way. In initial tests with casing perforated at 6,876-80 ft., the well made 46 bbl. of oil in 7 hours by swabbing. Since then, additional section has been opened by perforations at 6,860-64 ft., and, as this is written, the well is being cleaned for further testing.

At Eola, also in Garvin County, Sohio Petroleum Co. has deepened its 1 Henthrone, north extension well in the SE NW SE 7-1n-2w, to the McLish sand, deepest pay zone of the field, where in a drill-stem test, taking in an interval at 8,775-8,882 ft., the well flowed 297 bbl. of 34.9°-gravity oil in 3 hours through ½-in. bottom-hole and 1⅛-in. top-hole chokes. Top of the McLish was logged at 8,725 ft. with bottom of the hole at 8,897 ft. The well already has proved productive in the basal Bromide sand, another pay zone of the field, and the upper Bromide sand, a new pay zone for the field. Production also has been indicated in the Hunton, Viola, and Sycamore formations, all prospective new pay zones for the field.

Carter Oil Co. has logged additional promising showings at its 1 Rosendale, C NW SE 22-23n-24w, rank wildcat test in northern Ellis County, in far-western Oklahoma. With possible gas production previously indicated in the Pennsylvania-Morrow sand zone, topped at 8,400 ft., the well has been cored ahead into the Mississippian-Chester lime section, getting recoveries showing oil-staining, odors, and taste. As this is written, hole is coring at 8,620 ft. The test was started with a 9,800-ft. objective.

Continental Oil Co. has reached a depth of 11,861 ft. in Arbuckle dolomite at its 1 Kimball, NW NW SW 34-20n-16w, southern Major County, another western Oklahoma rank wildcat test, and is expected to plug back and test a previously indicated gas-distillate productive in Chester lime. Prospective pay zone in the Chester lime is at 8,382-8,428 ft., where a drill-stem test got a gas flow estimated at 5,000,000 cu. ft. per day and recovered 1,710 ft. of 56.5°-gravity distillate and 270 ft. of gas and distillate-cut mud. The well logged top of the Arbuckle at 11,695 ft. The latter zone also had some showings of gas. A 75-minute drill-stem test at 11,696-749 ft. in this section got a good blow in 10 minutes through a 3,500-ft. water cushion but then gradually died. A recovery of 675 ft. of gas-cut mud was made.

Helmerich & Payne, Inc., has run casing to test a prospective Hoxbar granite wash pay zone at its 1 Britton, C NE NE 28-9n-17w, a rank wildcat 3½ miles south of Cordell, Washita County, also in western Oklahoma, but on the south side of the Anadarko basin flanking the Wichita-Amarillo uplift. In a previously reported 2½-hour drill-stem test of that pay at 7,978-8,008 ft., the well flowed gas at an estimated rate of 825,000 cu. ft. and recovered 930 ft. of 43.9°-gravity oil. Since then, the hole has been drilled to 8,428 ft. in Springer sand, tentative top of which has been reported as 8,060 ft. Casing was run to 8,055 ft.

Delta Petroleum Corp. appears to have a good Misener sand discovery in Payne County at its 1 Rein estate, SE NE NE 31-19n-2e, 4½ miles west of Stillwater and 2 miles northwest of the Northeast Ramsey pool. With casing perforated at 4,650-70 ft., the well flowed 31 bbl. of oil the first hour through ½-in. choke. On a late test through ¼-in. choke, it flowed 14 bbl. in 2 hours. The well was drilled to 4,930 ft. in Wilcox sand, which proved dry. Casing was run to 4,833 ft.

OKLAHOMA SUCCESSFUL WILDCATS

Beckham County: Phillips Petroleum Co. 1 Hester, NW NW SE 4-7n-25w, flowed 1,781 M.c.f. gas from dolomite 1,854-1,963 ft., TD 2,055 ft.

Phillips 1 Oren "A," SW SW NE 36-8n-26w, flowed 1,442 M.c.f. gas from dolomite 1,903-88 ft., TD 2,013 ft.

Cleveland County: Anderson-Prichard Oil Corp. 1 Fant, NW NW 27-10n-2w, flowed 437 bbl. oil from lower McLish 7,761-79 ft., TD 8,001 ft. (New pay in Moore pool)

Garvin County: Phillips Chemical 1 Chem-Larnie, C NW SW 11-2n-3w, flowed 150 bbl. oil from Gibson sand and 102 bbl. from Hart at 7,706-25 ft., and 7,927-54 ft., TD 8,125 ft.

Hughes County: Public Service Co. of Oklahoma 1 Morton, C NE SW 18-8n-12e, flowed 670 M.c.f. gas from Booch 2,072-98 ft., TD 2,098 ft.

Okmulgee County: Henry D. Forker 1 Bogie, SW SE NE 12-13n-14e, flowed 96 bbl. oil from Wilcox 2,694-2,714 ft., TD 2,714 ft. (New pay in Morris pool)

Payne County: Wilcox, Amerada, Cities Service 1 Caldwell, NW NW SE 10-18n-2e, pumped 29 bbl. oil from Bartlesville 4,431-36 ft., TD 4,526 ft. (New pay in Lost Creek pool)

(Continued on page 398)

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Rocky Mountain

Denver - Julesburg Basin Reports New Discovery

DENVER.—The S. D. Johnson 1 Conockaert, NE NE NW 6-5n-56w, wildcat in Morgan County, Colorado, is the newest apparent discovery for the Denver-Julesburg basin. The well made gas at the surface in 7 minutes, with a slight spray of fluid at the surface in 22 minutes. The recovery was 900 ft. of oil, 90 ft. of oil-cut mud and 810 ft. of water, with flowing pressure 270 to 750 psi. and shut in pressure 1,525 psi. in 15 minutes. The test was of the J sand zone between 5,856-65 ft. with tool open 1 hour. This well is north of the Lee oil and gas pool and 6 miles southwest of the Messex pool. On the northeast side of the basin Argo Oil Co. - True & Brown of Denver tested water at 1 Kahl, NW NW SE 6-13n-40w, in the Bruel area, Keith County, Nebraska. The operator found shows in the zone 3,094-3,142 ft.

A wildcat of interest for future Dakota sand drilling in the San Juan basin is the Magnolia Petroleum Co. 1 Crandell, C NE NE 3-26n-9w, in the Huerfanita area, San Juan County. This well logged Dakota at 6,613 ft. and on drill-stem test 6,608-70 ft. there was gas at the surface in 8 minutes with an estimated flow of 100,000 cu. ft. daily. There was a spray of distillate in 48 minutes and recovery was 300 ft. of gas and distillate-cut drilling fluid. Another test 6,685-6,702 ft. showed 130 ft. of gas-cut drilling fluid. The operator is continuing to test with total depth at 6,723 ft.

Shell Oil Co. found shows of oil in the Mississippian at 34-26-G, NW SW SE 26-15n-54e, an extension test at Cedar Creek, Dawson County, Montana, and recovered slightly oil and gas-cut mud on test of that zone. The test was between 7,420-7,463 ft. and tool was open 90 minutes with the recovery 80 ft. of the oil and gas-cut mud. The company is coring below 7,475 ft. on the well. Kibby was topped at 6,761 ft. and the test was probably of the Madison zone, with no formation top reported below Kirby. The well is northeast of The Texas Co.'s Cedar Creek discovery well, which was completed as a Devonian oil producer and failed to find production in the Mississippian.

Another Shell Williston basin wildcat of importance is now in Mississippian, and of interest. The well is 22-25-B Northern Pacific, E½ SE NW 25-22n-48e, a wildcat in eastern McCone County, Montana. This well is now coring below 7,165 ft. with top of Heath at 6,320 ft. No shows have been reported for this well.

A wildcat failure was plugged by Hunt Oil Co. at 1 Shoemaker, C NE SW 3-157n-78w, McHenry County. The well went to 7,218 ft. total depth and found pre-Cambrian at 7,203 ft. No shows were reported on the well. Hunt is starting a third wildcat in the central area of the State, and is drilling below 5,600 ft. on 1 Wold, C SE SW 23-155n-81w, wildcat in Ward County.

In South Dakota Shell Oil Co. 1 Winter, C NW SW 11-22n-19e, topped Winnepeg at 7,929 ft. and is drilling below 8,100 ft. This well is the second in Shell's series through the Williston basin of this state, and the company will reportedly start the third well upon completion of the present test. This well had shows of oil in cores, with a small amount of lime oil reported on test 5,578-5,610 ft. in Madison. However, no commercial shows have been reported.

COLORADO SUCCESSFUL WILDCAT

Logan County, West Peetz: British-American Oil Producing Co. 1 Schwake, NE SW NE 6-11n-52w, IP gas lifted 222 bbl. oil daily through 12/64-in. choke, TD 5,663 ft. PBTD 5,344 ft. Greenhorn 4,890 ft., "D" sand 5,144 ft., "J" sand 5,273 ft., "M" sand 5,539 ft.

COLORADO WILDCAT FAILURES

Logan County: Eddie Fisher & John James 1 Teddy Rece, NW NW SW 9-9n-52w, dry, TD 4,881 ft. Graneros shale, 4,316 ft., "D" sand 4,544 ft., "J" sand 4,654 ft., Fuson 4,846 ft.

Vaughey & Vaughey 1 E. E. Britton, SW SW SE 7-9n-53w, dry, TD 5,152 ft., Greenhorn 4,645 ft., "D" sand 4,878 ft., "J" sand 4,980-5,092 ft.

MONTANA WILDCAT FAILURES

Cascade County: Hewson & Lewis 1 Hanson, C SW SE 18-21n-2e, dry, TD 792 ft.

Park County, Springdale structure: Wm. Hanlon et al 1 Murphy, NW NE NE 31-15n-12e, dry, TD 1,061 ft. Eagle 1,041 ft.

Teton County, Power area: Nairns & Par-

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sons 1 Siebealler, SE SE SW 18-23n-1w, dry, TD 1,820 ft., Madison 1,535 ft.

Toole County, North Gold Butte: The Texas Co. 1 Anthony Fey, C SW NE 18-37n-3e, dry, TD 3,810 ft. Blackleaf 1,343 ft., Bow Island 1,671 ft., Kootenai 2,485 ft., Swift 2,806 ft., Reardon 2,830 ft., Sawtooth 2,869 ft., Madison 2,920 ft.

NORTH DAKOTA WILDCAT FAILURE

McHenry County: Hunt Oil Co. 1 Shoemaker, NE SW 3-157n-78w, dry, TD 7,218 ft. Stonewall 5,776 ft., Red River 6,273 ft., Winnepeg shale 6,865 ft., Winnepeg sand 7,020 ft., pre-Cambrian 7,203 ft.

Central Area

ILLINOIS

Discovery of a new oil pool is indicated in Jasper County, where W. L. Griffith and associates recovered 2,160 ft. of clean oil with 120 ft. of water in a drill-stem test of saturation in McClosky lime at their 1 Brooks, SE SE SW 22-6n-9e, 4 miles southwest of Newton. The discovery is a mile northeast of production in the Bogota pool.

Saturation was logged at 3,100-10 ft. with bottom of the hole still in the pay. Tester was open 2 hours. Gas was at the surface in 15 minutes. Bottom-hole pressure was 912 psi. Casing has been run to 3,096 ft. preparatory to production tests.

Ryan & Sharp's new McClosky lime discovery well, 1 Apple, SW SW NW 28-5s-8e, 9 miles southwest of Carmi, White County, continues to pump and flow around 300 bbl. of oil daily without acidizing, and appears to be one of the district's best wells completed in recent weeks. It is more than 3 miles from other production, nearest being in the Stokes-Brownsville field to the southeast. Pay zone is at 3,385-95 ft., where casing, run to bottom of the hole at 3,460 ft., was perforated.

Drilling has been suspended at Superior Oil Co. deep exploratory test, 17-C Ford, C SW SE 27-4s-14w, in the New Harmony field, White County. Although no information has been released, total depth is reported around 7,900 ft. The test was started with the St. Peter sand as its objective. Approximately 5,200 ft. of 7-in. casing has been run and hole plugged back, indicating possibly that the test failed to find indications of production in the deep horizon, and will be tested in shallower zones.

INDIANA

F. B. Cline is opening a shallow Pennsylvanian sand pool in western Sullivan County at its 2 Riggs, NE SE SW 36-8n-11w. Starting production tests, the well swabbed at the rate of 45 bbl. of oil per day. Production is from 12 ft. of saturated sand at 778-90 ft. with bottom of the hole still in the pay. The location is 3 miles west of production in the Sullivan field, and 1½ miles from the Wabash River, the Illinois-Indiana boundary line.

WESTERN KENTUCKY

Stanford Oil Co. is proving a new, deeper pay zone, McClosky lime, for the Spottsville pool, 2 miles southwest of Spottsville, Henderson County. Its 1 Annie Stewart heirs, in 21-Q-25, is swabbing at the rate of more than 160 bbl. of oil daily from the new pay zone, opposite which casing is perforated at 2,251-57 ft. Total depth is 2,315 ft. Other production in the field has been from Aux Vases sand.

Extension of the small Midway pool in western Henderson County a half-mile to the north is in the making where Sinclair Oil & Gas Co. is testing its 1 Eblen, 20-P-21, prospective McClosky lime producer. A 90-minute test of the pay, logged at 2,612-23 ft., prior to running casing got gas to the top in 4 minutes and flowed clean oil after 84 minutes. Hole has been drilled to 2,643 ft. and casing run to 2,637 ft.

EASTERN KENTUCKY

In Elliott County and on the Sandy Hook anticline, Herchenroeder et al topped Corniferous lime at 1,292 ft. in 1 Ison and Greene and at total depth of 1,303 ft. was making 2 bbl. of oil daily. Operators are shut down pending decision to acidize. Test is a wildcat ½ mile east of the previously drilled dry hole.

In Greenup County, 19-X-79, and west of the town of Oldtown, Van Everman et al were getting ready to pump test 2 James Watt Floyd. Well was drilled to a total depth of 1,500 ft. in the Corniferous lime topped at 1,417 ft. Only a small show of oil was had on drilling in but upon acidizing with total of 3,000 gal. well flowed an undetermined amount of oil and acid water. New well is approximately 1,200 ft. northwest of No. 1 well completed in February.

MICHIGAN

Sun Oil Co. logged a Michigan Stray and so-called Marshall sand gas pays in a wildcat well in Hamilton Township, Clare County, which may prove to be important, although, after drill-stem tests of the gas-paying sections, well was being drilled on to deeper oil objectives, and may be drilled to the Richfield at about 5,700 ft.

Sun 1 Iutzi et al, NW SW SW 5-19n-3w, in the northwest corner of Hamilton Township, and over 2 miles northwest of the Hamilton gas pool which center around Sections 15, 23, and 26-19n-3w, logged Stray sand at 1,410 ft. On a drill-stem test of the top 12 ft. of this zone, from 1,410-22 ft., gas showed in just over 2 minutes and was gaged at 570,000 cu. ft. a day.

In the Marshall a gas pay was tested from 1,483-95 ft. Gas showed in 20 seconds and well gaged at over 2,000,000 cu. ft. a day. The gage used was good for

(Continued on page 398)

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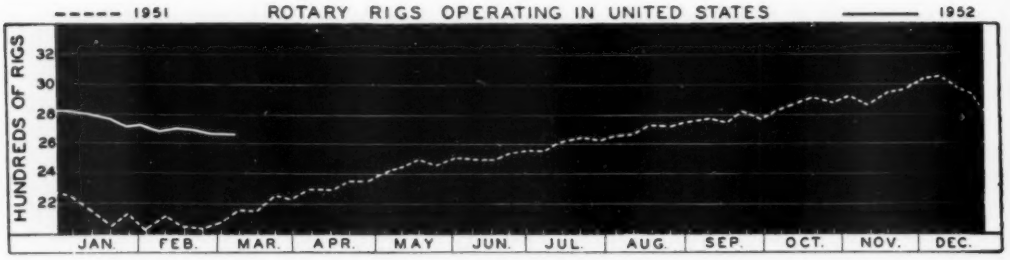
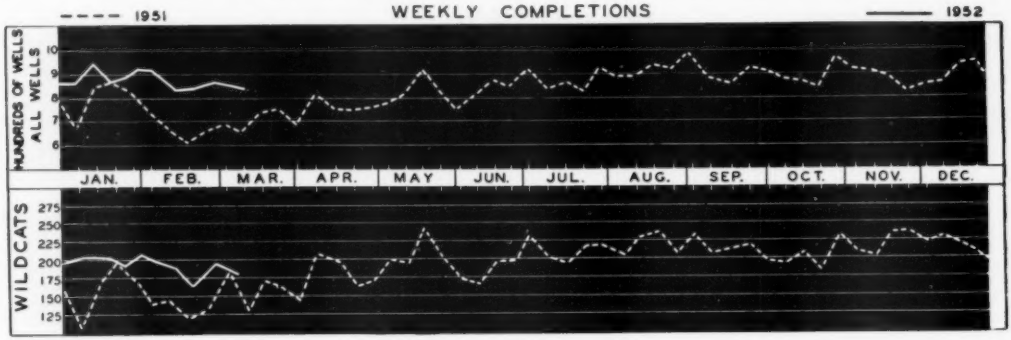




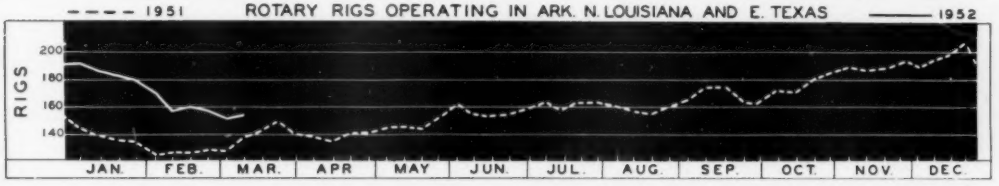
CURRENT STATISTICS

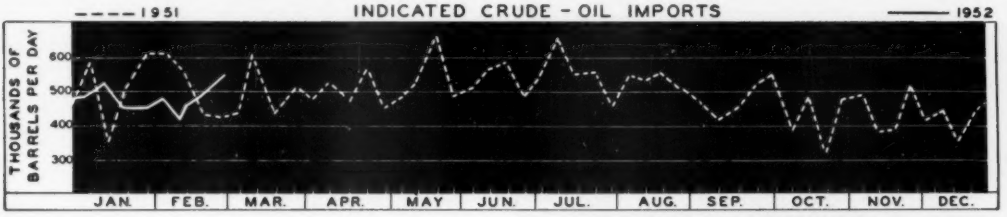
EXPLORATION

WEEKLY WELL COMPLETIONS . . . WEEK ENDED MARCH 8, 1952

	Total of all wells					Mar. 8		Wildcat completions and discoveries									
													Cumulative total, 1952				
	Comp.	Oil	Gas	Dry	Footage	1952	1951	Oil	Dist.	Gas	Dry	Total	Oil	Dist.	Gas	Dry	Total
New York	11	6	0	*5	16,200	87	15	0	0	0	0	0	0	0	0	0	0
Pennsylvania	26	9	4	†13	48,000	284	142	0	0	0	0	0	0	0	0	1	1
West Virginia	6	0	5	1	18,896	130	113	0	0	0	0	0	0	0	1	1	2
Ohio	22	7	3	‡12	52,072	162	141	0	0	0	0	0	0	0	1	0	1
Indiana	11	3	0	8	19,194	187	179	0	0	0	5	5	10	0	2	62	74
Kentucky	17	4	5	8	42,458	228	135	1	0	0	1	2	7	0	0	37	44
Illinois	46	21	0	25	118,103	280	332	0	0	0	11	11	2	0	0	65	67
Michigan	11	3	0	8	25,251	114	116	0	0	0	5	5	7	0	1	43	51
Kansas	74	40	5	§29	249,690	946	747	2	0	0	9	11	20	0	3	158	181
Nebraska	3	2	0	1	12,817	47	57	0	0	0	0	0	2	0	0	27	29
Oklahoma	134	64	9	¶61	501,106	1,225	989	4	0	3	19	26	14	1	6	129	150
Texas	306	194	7	105	1,421,483	3,312	2,927	22	2	0	63	87	144	13	21	752	930
North Central (Dist. 7-B & 9)	116	67	0	49	355,084	1,025	857	17	0	0	32	49	90	0	6	330	426
West (Dist. 7-C & 8)	85	68	0	17	489,937	1,025	905	2	0	0	7	9	23	0	1	117	141
Panhandle (Dist. 10)	4	3	1	0	12,003	118	139	0	0	0	0	0	1	0	1	14	16
Eastern (Dist. 5 & 6)	16	9	1	6	108,044	170	204	0	1	0	5	6	5	2	0	44	51
Gulf Coast (Dist. 2 & 3)	44	24	4	16	269,412	499	411	2	0	0	7	9	14	7	5	112	138
Southwest (Dist. 1 & 4)	41	23	1	17	187,003	475	411	1	1	0	12	14	11	4	8	135	158
Louisiana	35	28	2	5	229,747	421	368	2	0	0	3	5	8	3	1	45	57
Northern	19	14	2	3	74,969	235	168	1	0	0	2	3	3	0	1	21	25
Southern	16	14	0	2	154,778	186	200	1	0	0	1	2	5	3	0	24	32
Arkansas	4	2	0	2	13,451	69	68	0	0	0	0	0	2	0	0	9	11
Mississippi	8	3	0	5	58,378	82	43	0	1	0	4	5	4	1	0	34	39
Southeastern States	0	0	0	0	0	8	12	0	0	0	0	0	1	0	1	4	6
Montana	12	5	0	7	27,833	40	24	0	0	0	5	5	2	0	0	12	14
Wyoming	15	9	0	6	71,434	126	115	0	0	0	0	0	8	0	1	20	29
Colorado-Utah	16	11	2	3	85,707	110	44	1	0	0	2	3	7	0	2	35	44
New Mexico	24	13	8	3	123,220	175	121	0	0	0	2	2	4	0	1	13	18
California	58	43	2	13	241,597	478	343	3	0	0	9	12	21	0	0	90	111
North Dakota	1	0	0	1	7,218	2	0	0	0	0	1	1	1	0	0	1	2
Miscellaneous	0	0	0	0	0	12	7	0	0	0	0	0	0	0	4	2	6
Total United States	840	467	52	321	3,383,855	8,525	7,038	35	3	3	139	180	264	18	45	1,540	1,867
Total previous week	869	465	51	353	3,529,391			31	1	6	158	196	229	15	42	1,401	1,687
Total March 10, 1951	667	385	30	252	2,764,806			17	1	1	107	126	231	14	41	1,194	1,480

Service wells included: *5, †11, ‡1, §4, ¶8.

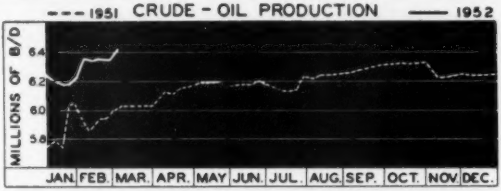


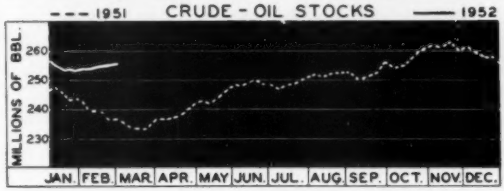


DAILY AVERAGE PRODUCTION FOR WEEK

	March 8, 1952 Crude oil	Lease condensate	Total	Mar. 1 total
Alabama	2,500		2,500	2,700
Arkansas	76,230	4,570	80,800	80,700
California	977,400		977,400	976,900
Colorado	81,400		81,400	79,200
Eastern	56,500		56,500	58,000
Florida	1,600		1,600	1,700
Illinois	171,000		171,000	160,700
Indiana	32,700		32,700	28,700
Kansas	313,500		313,500	323,000
Kentucky	35,900		35,900	35,300
Louisiana	626,475	45,100	671,575	657,600
North	112,750	15,100	127,850	127,650
South	513,725	30,000	543,725	529,950
Michigan	36,300		36,300	39,100
Mississippi	102,000	4,375	106,375	106,050
Montana	23,000		23,000	22,800
Nebraska	6,300		6,300	6,000
New Mexico	161,600	450	162,050	158,325
Oklahoma	522,300		522,300	518,800
Texas	2,910,375	47,700	2,958,075	2,919,725
Dist. 1	33,500	225	33,725	33,125
Dist. 2	166,575	3,875	170,450	170,500
Dist. 3	473,675	27,000	500,675	498,575
Dist. 4	268,750	4,700	273,450	267,700
Dist. 5	62,350	450	62,800	63,100
Dist. 6	126,850	4,600	131,450	128,375
East Texas field	265,000		265,000	271,300
Dist. 7-B	88,500	125	88,625	88,625
Dist. 7-C	140,625	5,925	146,550	143,475
Dist. 8	1,041,250	350	1,041,600	1,009,175
Dist. 9	161,175	450	161,625	162,650
Dist. 10	82,125		82,125	83,125
Utah	4,200		4,200	4,100
Wyoming	181,000		181,000	183,000
Total U. S.	6,322,280	102,195	6,424,475	6,362,400
Change from previous week, up			62,075	
Canada	90,750		90,750	103,925

Total U. S. production January 1-March 8 427,854,970 bbl.
Same period last year (crude plus cond.) 404,259,100 bbl.



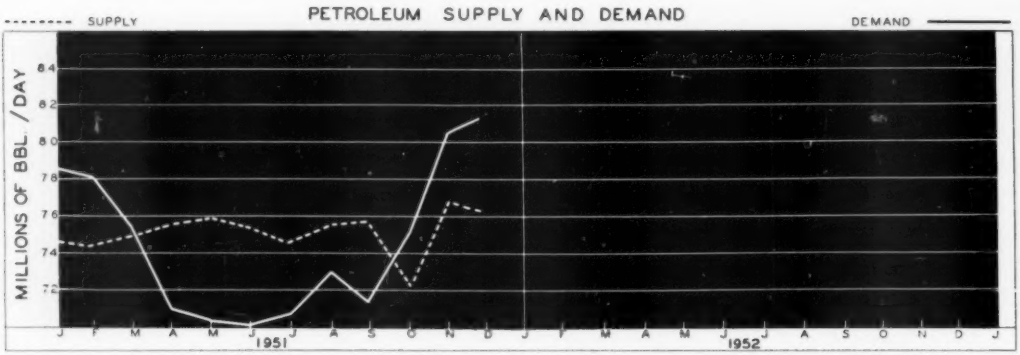


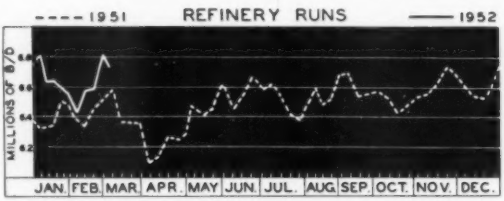
CRUDE-OIL STOCKS BY STATES OF ORIGIN*

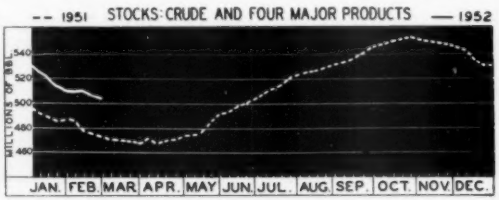
(Thousands of barrels)

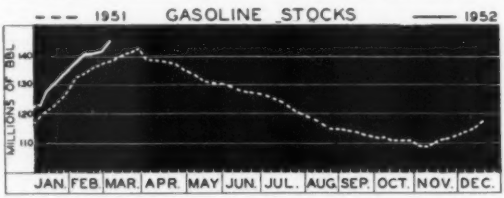
	Mar. 1, 1952	Feb. 23, 1952	Mar. 3, 1951
Pennsylvania Grade	2,129	2,100	2,081
Other Appalachian	2,135	1,903	1,284
Illinois, Indiana, Michigan	11,463	10,559	9,327
Arkansas	2,791	2,844	2,676
Louisiana	13,594	13,941	14,247
North	2,738	2,630	3,132
Gulf	10,856	11,311	11,115
Mississippi	3,437	3,384	3,029
New Mexico	7,752	7,636	6,975
Oklahoma and Kansas	39,019	40,008	37,810
Texas	122,669	121,523	110,785
East Texas proper	11,191	10,941	(†)
West Texas	55,668	55,461	(†)
Texas Gulf	25,261	24,973	(†)
Other Texas	30,549	30,148	(†)
Rocky Mountain	13,834	13,862	12,486
California	31,184	30,919	30,459
Foreign	6,445	6,505	5,649
Total	256,452	255,184	236,808

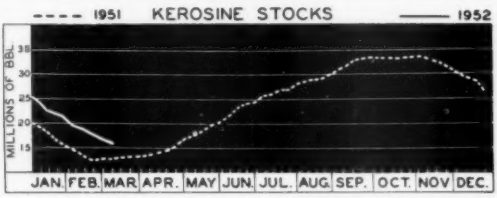
*Bureau of Mines. †Not comparable with currrent week.

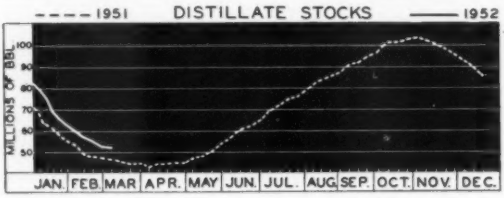


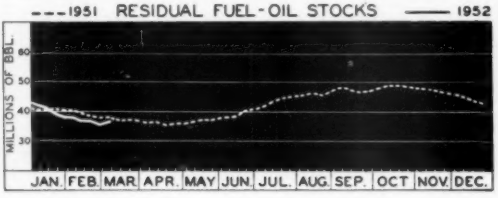










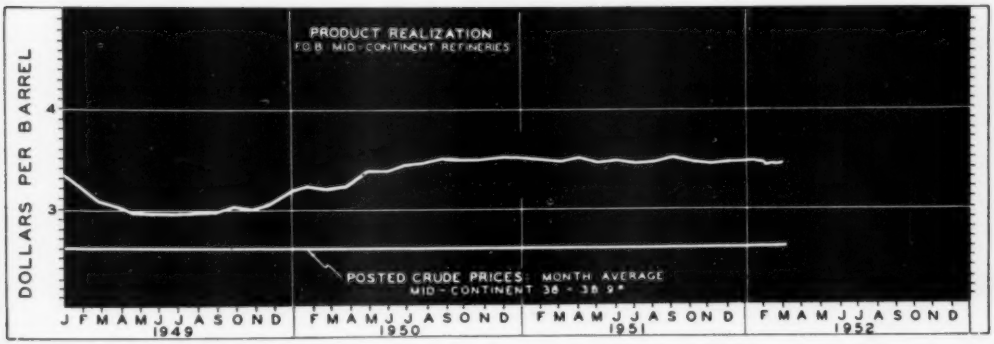


A.P.I. REFINERY REPORT, MARCH 8

(Thousands of barrels)

District—	Daily avg. crude runs	Daily average production				Stocks at refineries, bulk terminals, in transit and in pipe lines				Bureau of Mines, March 1951				
		Gasoline*	Kerosine	Distillate	Residual	Gasoline†	Kerosine	Distillate	Residual	Daily avg. crude runs	Daily average production			
											Gasoline*	Kerosine	Distillate	Residual
East Coast	1,015	387.2	37.1	227.7	235.6	25,944	5,861	14,492	8,969	1,000	371.6	47.0	245.1	235.6
Appalachian:														
District 1	102	47.0	6.3	21.6	16.0	3,089	306	527	410	101	40.3	7.0	15.0	13.4
District 2	84	36.7	5.9	15.0	23.1	1,345	125	372	138	77	32.8	5.4	10.8	18.2
Ind., Ill., Ky.	1,232	653.4	78.0	228.8	198.4	34,771	3,355	8,890	5,215	1,221	592.5	78.9	226.7	186.3
Okla., Kans., Mo.	541	295.0	18.9	128.3	65.3	17,434	1,104	6,660	1,268	529	274.0	16.5	126.6	75.1
Inland Texas	255	173.0	10.7	44.1	40.4	5,796	334	1,045	905	237	149.2	15.4	36.7	45.4
Texas Gulf Coast	1,681	749.9	145.4	399.3	274.9	25,076	2,569	6,853	6,318	1,572	688.2	136.0	364.4	274.3
La. Gulf Coast	505	227.0	45.9	167.6	60.0	7,510	1,307	2,957	1,851	486	226.9	65.2	109.1	63.8
N. La. and Ark.	78	34.4	7.3	16.9	7.1	3,034	427	749	182	68	24.8	7.3	17.6	7.8
Rocky Mountain:														
New Mexico	15	8.1		1.4	3.3	155		57	27	13	7.2	.3	2.5	3.2
Other Rocky Mtn.	217	97.0	8.0	44.6	45.7	5,425	217	1,297	979	222	103.6	7.5	41.2	47.1
California	1,010	383.4	9.1	173.8	347.2	15,377	234	5,727	10,825	943	396.5	12.6	131.0	377.3
March 8, 1952	6,735	3,092.1	372.6	1,469.1	1,317.0	144,956	15,839	49,626	37,087	6,469	2,907.6	399.1	1,326.7	1,347.5
March 1, 1952	6,816	3,183.0	337.0	1,581.7	1,386.3	142,787	16,683	52,489	36,441					
March 10, 1951	6,366	2,909.7	390.0	1,321.3	1,357.0	139,429	12,802	46,022	38,224					

*At refineries including natural blended. †Finished and unfinished.


PRODUCT REALIZATION
F.O.B. MID-CONTINENT REFINERIES
DOLLARS PER BARREL
4
3
POSTED CRUDE PRICES: MONTH AVERAGE
MID-CONTINENT 36 - 38.9°
J F M A M J J A S O N D
1949
F M A M J J A S O N D
1950
F M A M J J A S O N D
1951
F M A M J J A S O N D
1952

In this trend chart refinery realization is based on average Mid-Continent grade crude oil (not 38° gravity only) and average prices for refinery products as published in The Oil and Gas Journal basis Oklahoma (Group 3). Refinery yields confined to gasoline, kerosine, distillate, and fuel oil. Realization averaged $3.42 for week ended March 1, $3.43 for previous week, and $3.49 for March 1951. The above trend information is based on volumes and current prices and therefore does not reflect changes in operating costs.

REPRESENTATIVE QUOTATIONS

Representative spot-market quotations of leading suppliers as of March 12, 1952. Figures are f.o.b. plant for tank-car shipments in cents per gallon, except for residual fuel oil which shows the price per barrel and wax, in cents per pound.

GASOLINE, KEROSINE, AND FUEL OILS

	Mid-Continent Group 3	New York Harbor (barge)	Texas Gulf Coast
Regular gasoline, 80-82 octane	10-10¼	12-12.75	10¾-11
Premium gasoline, 86-88 octane	11-11⅜	13.5-13.75	11¾-12
42-44 w.w. kerosine	9-9¼	10-10.1	9
No. 2 straw fuel oil	8-8⅜	9-9.25	8
No. 6 residual	$1.45-1.55	$2.45-2.60	$1.75-1.90

NATURAL GASOLINE

	North Group 3	Texas	N. La.
Grade 26-70	5½	5	5¼
Grade 18-55	6.6	6.1	6.35

LUBRICATING OILS

South Texas

200 vis., No. 2-3 neutral	13-13.5
750 vis., No. 3-4 neutral	18
2,000 No. 5-6 neutral	18-19

LUBRICATING OILS

Mid-Continent

150-160 vis., D bright stock, 0-10 pp.	29
200 vis., No. 3 neutral, 0-10 pp.	16.5-17.5

Western Pennsylvania

145-155 vis., 10 p.t. bright stock	32.5
180 vis., 0 p.t. neutral	31.5

WAX

Mid-Continent

132-134 A.M.P.	5.5

PETROLEUM markets have reached the change-of-season point when most refiners are working out the required shift in yields to meet changes in product demands.

In District 2, refiners are watching the weather for an answer to the question of which product will cause trouble as the season changes. If weather is cold for the remaining weeks of March and the first half of April, stocks of heating oils may be reduced to near-normal levels. However, this condition would cut gasoline consumption at a time when gasoline stocks are at a peak. Mild weather for the next 4 weeks would increase gasoline consumption but would reduce heating-oil sales and leave a heavy carryover of distillate and kerosine stocks.

Gasoline stocks in District 2 reached a peak last year at the end of March when inventories had climbed to 50,121,000 bbl. Stocks were up to 50,135,000 bbl. by February 9 this year.

Some cold weather in the North Central states early in March increased demand for home-heating fuels, but most of the movement was out of pipe-line terminals. Since most refiners in the Mid-Continent had reduced tenders of No. 2 fuel, inventories of this product at some terminals are down to normal. Availability of kerosine and range oil on the line indicates that stocks of these products in line storage may be at a higher relative level than stocks of No. 2 fuel.

Residual fuel is still the softest product on the Group 3 market. District 2 inventories of residual on March 1 were larger than at any time during the 1950-51 winter season.

The extension of the strike truce for a month and the end of winter-level demands for heating oils will bring some kerosine and distillate out of storage into the open markets in Gulf Coast and East Coast areas. While heavy fuel is not available on the open market in these areas, reports indicate that regular customers' needs are being met in full. Any definite indication of an Iranian agreement that would open the Abadan refinery by summer would bring some closely held residual out of storage.

CRUDE PRICES

GRAVITY SCHEDULE

	Signal Hill, Calif.‡	Oklahoma, Kansas	Gulf Coast Tex.*	West Tex.†
18-18.9	$1.93			
19-19.9	1.98			
20-20.9	2.03	$2.25		$2.12
21-21.9	2.07	2.27		2.14
22-22.9	2.12	2.29		2.16
23-23.9	2.18	2.31		2.18
24-24.9	2.24	2.33	$2.56	2.20
25-25.9	2.30	2.35	2.58	2.22
26-26.9	2.36	2.37	2.60	2.24
27-27.9	2.41	2.39	2.62	2.26
28-28.9	2.46	2.41	2.64	2.28
29-29.9	2.52	2.43	2.66	2.30
30-30.9	2.57	2.45	2.68	2.32
31-31.9	2.62	2.47	2.70	2.34
32-32.9	2.68	2.49	2.72	2.36
33-33.9		2.51	2.74	2.38
34-34.9		2.53	2.76	2.40
35-35.9		2.55	2.78	2.42
36-36.9		2.57	2.80	2.44
37-37.9		2.59	2.82	2.46
38-38.9		2.61	2.84	2.48
39-39.9		2.63	2.86	2.50
40 and above		2.65	2.88	2.52

*For crude from Daboval, El Campo, and Sand Point.

†Includes Lea County, New Mexico. Last general price change represented a 50-cent increase becoming effective December 6, 1947.

‡Standard Oil Co. of California.

FLAT CRUDE PRICES

Representative posted schedules per barrel.

Kettleman Hills, California*	$2.80
Louisiana:	
Beauregard Parish	2.60
Cotton Valley (distillate)	2.85
Cotton Valley (crude)	2.70
Texas:	
East Texas	2.85
Pecos County (Yates)	2.35
Conroe	2.83
Van	2.48
Pennsylvania Grade:	
Bradford	4.25
Southwest Pennsylvania	3.82
West Virginia	3.76
Illinois Basin	2.77

*37°-37.9°.

EQUIPMENT MEN . . . in the News

Birnie Made General Sales Manager of Welex Jet

A. M. BIRNIE

Albert M. (Bert) Birnie has recently joined Welex Jet Services, Inc., as general sales manager, according to announcement by R. H. McLemore, executive vice president. Birnie is responsible for the over-all supervision of Welex sales activities, and will work closely with the company's 3 division managers and 10 district managers.

Welex has recently expanded its services to the oil industry through the addition of radioactivity well logging. At present the logging service is being offered in the Gulf Coast division, and will be expanded as rapidly as equipment deliveries will permit.

Birnie was regional manager with Security Engineering Co. for 7 years before joining Welex Jet Services.

Ratcliffe Is Elected a Vice President of National Lead

G. L. RATCLIFFE

George L. Ratcliffe has been elected a vice president of National Lead Co., according to an announcement by J. A. Martino, president. Ratcliffe has been a director of National Lead since 1948 and general manager of the Baroid Sales Division of the company since 1929.

Ratcliffe joined National Lead in 1929. At that time he was president and general manager of California Talc Co., one of the predecessor companies to the present Baroid Sales Division. Prior to the organization of California Talc, he also saw service with Standard Oil Co. of New Jersey, Texas Pacific Coal & Oil Co., and General Petroleum Corp.

Macco Corp. Advances Brookbank, Hawkins

Edward A. Pellegrin, vice president and sales manager of Macco Corp., recently announced the following advances, which became effective February 15. Lake Brookbank was appointed manager of sales of the rig-building department. J. D. Hawkins

LAKE BROOKBANK

J. D. HAWKINS

was appointed manager of sales of the drilling-fluid division.

Brookbank has been with Macco for the past 6 years, 5 of which were spent in charge of rig-building sales in the San Joaquin Valley. In 1951 he was made a salesman in the Los Angeles Basin and other California areas. He was formerly affiliated with International Derrick & Equipment Co. for 7 years, and prior to that time he was with Shell Oil Co. as field engineer.

Hawkins was formerly employed by Union Oil Co. for 16 years. In 1949 he joined Macco where he had charge of the drilling-fluid division of sales in the Los Angeles Basin. In his new capacity he will supervise sales out of the Bakersfield, Rosamond, Huron, Rio Vista, and Ventura, Calif., branch plants, as well as the Los Angeles Basin.

Two Sales Changes Made By Oil Center Tool Co.

Oil Center Tool Co. of Houston has announced two important sales-department changes, according to Rex E. Galloup, O-C-T sales manager.

M. E. HUNTER

M. G. ESTERAK

M. E. (Mike) Hunter has been named manager of the Southwest Texas district with headquarters at Corpus Christi. An employe of O-C-T since 1937, he was stationed in Victoria, Tex., before being transferred to Corpus Christi.

Myles G. Esterak has recently joined O-C-T organization and is a sales representative in the Southwest Texas district with headquarters in Victoria. Before joining O-C-T, he was associated for several years with Republic Supply Co. in Victoria.

Billue Announces Formation Of Two New Companies

G. H. (Smoky) Billue, formerly manager of Hydrocarbon Storage, Inc., has announced the formation of two new firms, both with headquarters at Wichita Falls, Tex. Billue will supervise the operations of both companies. Securities Underground Storage Co. will handle complete underground storage facilities on a contract basis. This service will include underground storage locations, and consultation on underground storage problems in new areas.

Wes-Tex Engineering & Sales will handle A.P.I.-A.S.M.E. inspection and materials expediting of new and used equipment for refineries and natural-gasoline plants as well as other field-processing installations. This firm will specialize in vessels, pumps, and valves.

Waukesha Opens New Office and Warehouse

Waukesha Sales & Service has opened this new office and warehouse at Corpus Christi, Tex., to provide better parts facilities and more efficient service for Waukesha engine users in South Texas area. R. F. Park is branch manager, and F. M. McCarthy district manager.

Hughes Tool Names Myers, Fleetwood to New Division

A steady increase in drilling activity has resulted in Hughes Tool Co. creating a new large division by combining the northern part of West Texas with Wichita Falls district.

Park L. Myers, formerly manager of the Ark-La-Tex division, has been promoted to manager of the new North Texas division wth headquarters in Wichita Falls. Clyde W. Fleetwood has been promoted to the managership of the Ark-La-Tex division with headquarters in Shreveport.

P. L. MYERS

C. W. FLEETWOOD

Myers' association with Hughes dates from 1937 at which time he started working for the company during summer vacations while attending University of Texas.

Fleetwood has been with Hughes Tool since graduating from Oklahoma University in 1935. He has had varied and wide experience with Hughes in Oklahoma City, Seminole, Illinois, and West Texas. Prior to his promotion he was district manager of the North Texas district at Wichita Falls.

Wilcox, Siracusa Make Extended Trip for Bowen Co.

Jack Wilcox, president of S. R. Bowen Co., and Dante Siracusa, sales manager, left California early in January on a visit to the company's stores and sales agents.

Their plans call for a study of field conditions in Texas, Louisiana, Oklahoma, Kansas, Rocky Mountains, and Canada, and the introduction of several new Bowen tools in these areas.

Calumet, Hecla Coordinates Divisional Advertising

E. R. Lovell, president of Calumet & Hecla Consolidated Copper Co., Boston, has announced that the advertising of the corporate organization and its divisions has been coordinated under one advertising department staff. H. A. Harty, advertising manager of Wolverine Tube Division is advertising manager of the Calumet Division, and will also direct the corporate advertising program. Headquarters for the expanded advertising department will be maintained in Detroit.

At the same time, announcement was made of the appointment of Charles M. Gray & Associates, Detroit, as the advertising agency which will handle Calumet Division campaigns and corporate program.

Tube-Kote Announces Completion of New Office Building

Tube-Kote, Inc.'s newly completed office building

L. E. (Larry) Heinen, president of Tube-Kote, Inc., has announced the completion of the company's new $50,000 office building on the grounds of the plant's 15-acre tract in Houston.

This new building brings to five the number of structures on the Tube-Kote lot. Among the features of the new building are rubber-tile flooring, sound-absorbing ceiling, roll-out partitions, and indirect fluorescent lights.

Tube-Kote was established in 1939 as a research group to study the effects of corrosion in oil-field drilling and production. In 1943 the present plant was erected to process both new and used tubing.

Officers of the company, in addition to Heinen, are John A. Croom, secretary, and W. H. Hopkins, treasurer.

Mid-Continent Announces Three New Appointments

Ken W. Davis, president and general manager for Mid-Continent Supply Co., recently announced the following appointments: T. N. Shults has been appointed export manager for Mid-Continent's New York division office. Ben S. Harkrider has been made district manager at Wichita, Kans. Gilbert A. Metz has been named district machinery manager of the company in Casper, Wyo.

T. N. SHULTS

B. S. HARKRIDER

G. A. METZ

Shults was employed by Mid-Continent in December 1939. He has worked successively in the Fort Worth purchasing department, field salesman at Kermit, Tex., and city salesman at Fort Worth. In 1946 Shults went to Tulsa as city salesman, and since 1947 he has been in New York as export sales engineer and assistant export manager.

Harkrider has been associated with the company since 1937. He was first employed at Rodessa, La. In 1938 he was sent to Magnolia, Ark., and was promoted to field salesman in 1939. He became store manager at the same location in 1940, and in December 1940 he was transferred to store manager at Duncan, Okla.

Metz joined Mid-Continent in 1946 at Odessa, Tex. He was promoted to field salesman in July 1947. Becoming machinery salesman in 1948, he was transferred to Fort Worth in that capacity in 1950, and was made manager of the quotations department in 1951.

B-J Appoints Rees Manager of Exports

Earl M. Rees has been appointed manager of export for Oil Tool and PB divisions of Byron Jackson Co. and BJ Service, Inc., according to an announcement by B. A. Hilliard, general sales manager, Oil Tool division. Rees replaces O. W. Morgan, Jr., who has resigned.

E. M. REES

Rees became affiliated with Byron Jackson in 1946 when the Patterson-Ballagh Corp. became a wholly owned subsidiary. During the past 24 years Rees has traveled extensively in visiting most of the oil fields overseas.

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FOR SALE: One St. Regis Type 301 FB Valve Bag Filling Machine equipped with guards, solenoid tripping device for cutoff valve. Machine approximately 18 months old and has had very little use. Original cost $2750. If interested call or write Husky Oil Company attention of C. A. Colbern, Box 380, Cody, Wyoming, or telephone Cody, Wyoming, 500.

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95,000′	3″	(3½″ O.D. x	6#)	E.W.	30′	1000 PSI.
40,000′	3½″	(4″ O.D. x	6#)	E.W.	30′	1000 PSI.
15,000′	3½″	(4″ O.D. x	7#)	E.W.	30′	1000 PSI.
55,000′	4″	(4½″ O.D. x	7.25#)	E.W.	40′	1200 PSI.
100,000′	4″	(4½″ O.D. x	8.4#)	E.W.	20′	1000 PSI.
35,000′	4″	(4½″ O.D. x	10.79#)	E.W.	20′	1000 PSI.

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Reconditioned Drilling Rig Complete. Consists of the following: Wilson double drum giant model drawworks, driven by EKU Waukesha gas engine. FXZ Gardner-Denver power pump driven by model NKU Waukesha gas engine, pump and engine unitized on sub base with V-Belt drive and guard. Double 87 ft. telescoping mast pole with racking platform for 5000' 3½" drill pipe. Oil Well model 100 swivel; 17½" oil bath rotary table with bushings; 5000' 3½" drill pipe; six 5¼" x 2¼" x 27' used drill collars; 5KW light plant; Brewster H-100 combination hook and block; 4¼" x 37 ft. kelly.

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FOR SALE AT BARGAIN: Heavy Duty Pumping Unit for handling large volume fluid. Parkersburg J-53-30, double reduction Herringbone gear reducer complete with Buda JL-877 Standard unit with accessories. Motor newly reconditioned. Unit about seven years old but actually in use only short time. First class condition. Now located near Cromwell, Oklahoma. Wrightsman Oil Company, 218 First National Bank Building, Holdenville, Oklahoma.

FOR SALE

36-L Bucyrus-Erie Spudder, Trailer Type complete tailing in tools for 5" and 7" pipe—New 3500' lines ⅞" and ⅞"—Steel Dog House—Junk Rack—Forge—1500 W Koeler Light Plant—Everything propane equipped. Contact **Herbert H. Hart, 2266WI, El Dorado, Kansas, or Charles V. Cross, 125 Madison, Kansas.**

RECONDITIONED #1 USED BLACK PIPE MECHANICALLY CLEANED AND STRAIGHTENED

APPROXIMATELY 20' RANDOM LENGTHS

100,000'—2⅜" O.D. Std. Pipe, 3.67#, B.E.
100,000'—3½" O.D. Std. Pipe, 7.62#, B.E.
20,000'—5½" O.D. Std. Pipe, 15.00#, B.E.
200,000'—6⅝" O.D. Std. Pipe, 18.97#, B.E.
300,000'—8⅝" O.D. Std. Pipe, 28.55#

CALL! WIRE! WRITE!

ALERT STEEL COMPANY
3100 East 87th St. Chicago 17, Ill.
ALL PHONES: ESsex 5-2200

All Steel

OIL STORAGE TANK

100,000 gallon capacity, 34 feet diameter, 20 foot high. In good condition.

PRICED RIGHT TO SELL

(as is—where is)

Located at Deepwater, Mo. Formerly Dickey Clay Plant.

Write, wire or phone

B & G SUPPLY CO.

3rd & Pacific . . . Kansas City, Kans.
Phone DR. 5900

We Buy or Dismantle Obsolete Plants

For Immediate Shipment

Unused

24 & 26" O.D. Steel Pipe

Sub-Standard Grade

SUITABLE FOR CULVERTS and OTHER PURPOSES

Priced Attractively

HYMAN-MICHAELS COMPANY

122 South Michigan
Chicago 3, Illinois
WAbash 2-4911

FOR SALE: The following New Material at ½ Retail Price. 8 6" FE 90° Base Elbows Ser. 600 Cast Steel Fittings. 4 8" FE 90° Ser. 400 Cast Steel Fittings. 4 10" FE Ser. 300 Cast Steel Fittings. If interested contact Mr. Bert Rogers, Texon, Texas.

FAILING 5500 Rig, 40 ft. Derrick, Rotary Pump mounted K8 International Truck, 1,038 ft. 3½ Drill Pipe, 48 Chevrolet Truck, trailer, 30 bbl. water tank. Rig complete at Coleman, Texas, $17,500.00. The Oil Corp., 1005 Wilson Bldg., Corpus Christi, Texas.

USED well drilling equipment. We buy and sell spudders, rotaries, core drills, tools, pipe, blocks, pump jacks, everything for well drilling and service. All used equipment fully reconditioned. Contact us for your requirements and save money. We rent fishing tools. Pressey & Son, Pueblo, Colo.

FOR SALE: Approx. 3000' of 3½" modified drill pipe, 1 Wichtex Draw-works, 65' mast, 1 17" Oil well Rotary table, 1 C-100 Ideal 6¼" x 10" mud pump complete with motor, 1 PA-100 International Draw-works motor, 1 GMC truck 2½ ton tandem, 1 Ford truck 1½ ton, both oilfield beds & winches. Have all other equip. necessary for complete rig that isn't listed. Rig now working, price, $27,500.00. F. H. Graves, 805 W. Main, Marietta, Oklahoma. Phone 480.

FOR SALE: National Drilling Machine 3A 660, 1947 Model with OCS sand reel. Young drilling engine. Drilled less than 40,000 ft. of hole complete and ready to drill. Cash sale only. Inspection by appointment. Doak & Hughes, Phone 922, Box 568, Bristow, Oklahoma.

FOR SALE: Westcott, Foxboro and Emco Gas Meters. George R. Milner, Box 124, Okmulgee, Oklahoma.

SHOT HOLE RIG for Sale: Franks K.C. 45 on 1946 Chev. truck. Dodge Water truck, 1951. 200 ft. of drill pipe. Call or write E. E. Hubbard, 1206 N. 11th St., Garden City, Kans. Call 4926.

FOR SALE: 3A National Cable tool machine with JL, 1335 Buda Engine and Youngs Drilling Clutch. Price $5000.00. C. L. Hinds, Box 194, Ulysses, Kansas.

10—8000 GAL. steel 12x10' tanks, vert. open top ¼" plate, have ⅜" plate to enclose end, like new, painted outside, clean and free from rust on inside. Hepperly Equipment Co., 4900 West Madison Street, Chicago, Illinois.

FOR SALE: 723 used Victaulic couplings and gaskets for 6⅝" OD spiral weld line pipe. Price $1.59 each. 256 used Gustin Bacon-Groovagrip couplings and gaskets for 8⅝" OD spiral weld line pipe. Price $2.08 each. The Drillers Gas Company, 24 West 5th Street, Hutchinson, Kansas.

THREE Buda Engines 4 cylinder 3½" bore; 4½" stroke, Model H-173. Brand new and complete less clutch. Cost $640, take $240 each. Box E-669, The Oil and Gas Journal, Tulsa, Okla.

NEW OIL WELL CASING

Immediate delivery, 7200 feet 5½", 17 pound, range two, seamless, J-55, threaded & coupled, new prime material. No PAD required, conversion material. Price $2.90 per foot, FOB Ohio.

GREAT PIPE & STEEL CORP.
1159 S. Broadway, Los Angeles 15, Calif.

FOR SALE

1, Franks Model SAL 5000 Rotary Rig, and sub-structure complete, in good condition, equipped with 3 new gas engines, including 5500 ft., 4½-in. drill stem, 3 Oilfield trucks and 2 trailers. Immediate possession, including drilling contract if desired. TERMS. Also have Oil leases in Colo., Wyo., & Nebr., for sale or farm-outs and some royalty in Colo., and Nebr.

Phone or write

SUHR, FIEDLER, LOCK DRILLING CO.
Holyoke, Colo.

EQUIPMENT FOR SALE

FOR SALE: Wilson Giant Drawworks: 2 Buda JL-1335 Motors with chain compound drive. 1—Code Butane Tank. 4000' 4½" Drill Pipe. May be inspected while drilling 4000' wells near Hays, Kansas. Total price $17,-000.00. Powell Drilling Company, 306 Derby Bldg., Wichita, Kansas.

FOR SALE: Wilson Giant Rig complete with 2 250 H.P. Cummings Diesel Engines compound; 96 foot Hi Speed Lee C. Moore Mast; 4000 feet nearly new Drill Pipe; 7¼ x 14 Pump, measuring lines, etc., complete ready to drill. Box E-668, The Oil and Gas Journal, Tulsa, Oklahoma.

FOR SALE: 2 New Continental Engines 33R, 90 H.P. with new Cotta Transmissions, two speeds forward, one reverse. Price: $1500.00 ea. F.O.B. Beaver Falls. Keystone Driller Co., Beaver Falls, Penna.

WANT EQUIPMENT: Did you find the equipment you wish to purchase in this column? If not, use an "Equipment Wanted" classified advertisement to find it. It is available somewhere and Journal classified advertisements will find it. See box heading for classified rates, or write The Oil and Gas Journal.

EQUIPMENT WANTED

HIGHEST prices paid for Cable Tools, Machines, Equipment, Pipe and Supplies. Degen Pipe & Supply Co., Box 107, Redfork Station, Tulsa, Oklahoma.

WANTED TO BUY: Tubing threader, must be in good condition and reasonable. Western Well Service, Odessa, Texas.

1,400 FEET or less 3½" EUE or 2⅞" EUE drill pipe, new or good used. One 30 foot 4¾" drill collar, new or good used. Have PAD authorization for pipe. Box E-606, The Oil and Gas Journal, Tulsa, Oklahoma.

WE BUY well drilling equipment, machines, cable tools, pipe, etc. Turn your surplus equipment into cash. Pressey & Son, Pueblo, Colorado.

WILL PAY highest prices for used casing, used line pipe, abandoned leases, or other surplus lease equipment. Your idle producing equipment is worth dollars. Green Pipe & Supply Co., Box 1383, Tulsa, Oklahoma.

EQUIPMENT NOT IN USE: Did you find a buyer in this column for the equipment you have for sale? Someone wants it and an "Equipment For Sale" classified advertisement in the Journal will find a buyer. See box heading for classified rates or write The Oil and Gas Journal.

HELP WANTED

REFINERY OPERATORS

Expanding major gulf coast oil refinery has openings for experienced refinery process operators. Progressive company with attractive benefits. Requires 2-4 years operating experience on major refinery units. Good opportunity for experienced Helpers to become Stillmen. Housing available within immediate area. Reply giving detailed experienced, age, education and wage expected. Replies treated confidentially.

Box E-647, The Oil and Gas Journal, Tulsa, Oklahoma

HELP WANTED

COMPUTER—College degree and two years of experience as Computer and Observer on seismograph crew. To be given intensive training toward position of Party Chief. Write us giving full details of education and experience and salary expected. Geotechnical Corp., Box 7168, Dallas, Texas.

REFINERY MACHINIST FOREMAN

Progressive major oil company needs Machinist Foreman for expanding Gulf Coast refinery. Most modern equipment in industry; attractive employee benefits; housing available in nearby area. Requires capabilities to take charge of machinist department; experience in both outside and inside machinist work; and a thorough knowledge of pumps, turbines, and centrifugal and reciprocating compressors. Give detailed experience, age, education and salary expected. Replies held confidential. Box E-656, The Oil and Gas Journal, Tulsa, Oklahoma.

ASSISTANT UTILITIES ENGINEER

Career positions with California Public Utilities Commission. Requirements: Degree and two years with utility or allied industry. (Some substitution in qualifications allowable.) Interviews in California only. Write for full information on salary, opportunities, benefits, etc., to **State Personnel Board, Dept. O, 1015 L Street, Sacramento, California.**

MANUFACTURERS REPRESENTATIVE or SIDELINE SALESMAN WANTED

calling on the oil industry and supply houses to represent large manufacturer of Wiping Rags and Cotton & Wool Waste.
We offer a marvelous Opportunity to the right man with a following. Top commissions paid. State what territory you now cover. Exclusive territorial rights can be arranged. This is a high quality competitive line. Well known brand. Give full information 1st letter.

COLUMBIA WIPING CLOTH COMPANY
1720 Wabash Kansas City, Mo.

PETROLEUM ENGINEERS

Major Oil Company has openings for a number of Petroleum Engineers for service in South America & Middle East. Requirements: B.S. degree in P.E., M.E. or Chem.E.; to 3 yrs. Experience.

GULF OIL CORPORATION
Foreign Production Div.
P.O. Box 35, N.Y. 4, N.Y.

OPPORTUNITIES FOR TECHNICAL REFINERY PERSONNEL for LARGE INTERNATIONAL OIL COMPANY

Entertaining applications of graduate chemical, mechanical, structural and electrical engineers for refinery engineering assignments at home and abroad.
Engineers with refinery experience and also recent graduates will be considered.

Box E-667, The Oil and Gas Journal, Tulsa, Oklahoma

HELP WANTED

ADMINISTRATIVE and field sales personnel. Engineering education and/or background necessary. Knowledge of petroleum and chemical industries desirable. Apply: The J. B. Beaird Company, Inc., P.O. Box 1115, Shreveport, Louisiana.

GEOLOGIST to organize, and to direct Geological Department for exploration, and production Div. now being organized, for a well established Natural Gas Co. Must be thoroughly familiar with South Louisiana, and also experienced in North Louisiana, Mississippi and East Texas, and capable of handling the geology in other areas in which the company may want to expand. Salary commensurate with ability and job to be done. Office in New Orleans, Louisiana. Box E-645, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED: Chief Engineer, preferably one who has had at least six or more years in refining with some asphalt and processing engineering experience to take charge of maintenance and new construction. Location Northeast Texas. Box E-558, The Oil and Gas Journal, Tulsa, Oklahoma.

KEY Seismograph Personnel Needed by Established and Expanding Seismograph Company. Box E-616, The Oil and Gas Journal, Tulsa, Oklahoma.

EXPERIENCED Engineers, Geologists, Draftsmen, Geophysical field men, write for information on Rocky Mountain positions now open. Professional Placement Service, 516 University Bldg., Denver, Colo.

EXPERIENCED surveyors for foreign service with gravity crews. Top salary, subsistence, travel expenses. Our personnel have knowledge of this ad. Apply Box E-661, The Oil and Gas Journal, Tulsa, Oklahoma.

MECHANICAL engineer needed by prominent Northwest area water well contractor. Should have actual experience in drilling and knowledge of deep well turbine pumps and municipal sales experience. Excellent opportunity for qualified man. Reply will be held confidential. Write to Box E-658, The Oil and Gas Journal, Tulsa, Oklahoma.

NEED PHYSICISTS and ENGINEERS for RESEARCH AND DEVELOPMENT

In the fields of geophysics and well logging. Work includes the measuring, telemetering, recording and evaluation of electric, magnetic, acoustic, radioactive and other characteristics of earth materials. Laboratory located in Houston, Texas.

HALLIBURTON
OIL WELL CEMENTING CO.
ELECTRICAL
WELL SERVICES LABORATORY
1625 OLD SPANISH TRAIL
HOUSTON 25, TEXAS

●

IN NEW YORK CONTACT:
HALLIBURTON
OIL WELL CEMENTING CO.
2414 CHASE NATIONAL BANK BUILDING
20 PINE STREET
NEW YORK 5, NEW YORK
J. K. REYNOLDS

●

IN LOS ANGELES CONTACT:
HALLIBURTON
OIL WELL CEMENTING CO.
1709 WEST 8TH STREET
LOS ANGELES 17, CALIFORNIA
W. B. McCOY

HELP WANTED

HELP WANTED—Experienced landman to head up land department for aggressive integrated independent oil company. Headquarters Houston. Please state age, qualifications and starting salary expected. Address Box E-654, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED: Rotary drillers familiar with truck mounted rotary portable drills and reverse hydraulic drilling and who have had experience in water well drilling. Excellent hourly pay, travel time and subsistence—a good job for the right man. Must have references. Box E-659, The Oil and Gas Journal, Tulsa, Oklahoma.

COMBINATION, cable and rotary, sober and industrious driller year round work, good pay. Gray Well Drilling Co., Delafield, Wisconsin.

WANTED—Cable tool drillers familiar with 24L, 28L and 36L rigs who have had experience in water well drilling and turbine pumps. Steady year-around work for the right man. Please give references. Box E-657, The Oil and Gas Journal, Tulsa, Oklahoma.

EXPERIENCED gravity party chief-supervisor for foreign service. Top salary and expense allowance. Family can accompany. Our personnel have been notified. Apply Box E-660, The Oil and Gas Journal, Tulsa, Oklahoma.

FOR SOUTH AMERICA: Micropaleontologist. Seismologist. Graduates in Geophysics, mathematics or physics to train as seismologists. Experienced Graduate Drilling Engineer. Experienced Graduate Reservoir Engineer. No fees. Oil Industry Employment Service, 405 Tuloma Bldg., Tulsa, Okla. 4-5974.

NOW READY. List showing where to apply for foreign oil jobs. Write for price. OIML Co., Box 2603, Tulsa, Okla.

THE POSITION YOU WANT: Oil industry companies are looking for men to fill every conceivable kind of position. If you didn't find the position in this column that you are looking for, use a "Situation Wanted" classified advertisement to state your qualifications. Some company is probably looking for your ability. See box heading for classified rates or write The Oil and Gas Journal.

SITUATIONS WANTED

17 YEARS Oilfield Experience—Drilling and Production as well as Technical and Management. Desire connection with stable independent. Prefer Rky. Mtn. area. Box E-632, The Oil and Gas Journal, Tulsa, Oklahoma.

REFINERY MANAGER, extensive experience, desires connection with independent company. Box E-601, The Oil and Gas Journal, Tulsa, Oklahoma.

SUPERINTENDENT or Chief Engineer job, petroleum engineering degree, experience in production and completion work, Age 34. Box E-649, The Oil and Gas Journal, Tulsa, Oklahoma.

ATTENTION: Well established oil well drilling contractor desires to manage and supervise: Individuals', groups', small or medium-sized oil companies' drilling, production and operating problems in Central and Western Texas, and New Mexico. Personal interview by appointment is desired. Makin Drilling Company, Box No 1628, Ph. No. 131, Hobbs, New Mexico.

TRAFFIC MANAGER Cost Accountant. College, Age 27, single, no drinker, Jewish, desires oil industry connection. State nature of position you can offer. Robert G. Segal, 1003 Vincent Ave., North, Minneapolis, Minn.

GRADUATE Engineer: 8 years varied drilling, completion, workover and production experience, desires responsible engineering or production position with active independent. Box E-633, The Oil and Gas Journal, Tulsa, Oklahoma.

ENGINEER, 25 years experience foreign and domestic refinery construction, operation, inspection, estimating, project engineering, planning, etc. Desires change. Mechanical and Chemical Engineering training, registered Prof. Engineer. Speaks several Languages. Box E-665, The Oil and Gas Journal, Tulsa, Oklahoma.

SITUATIONS WANTED

15 YEARS experience in drilling and production supervision. Desire position with independent oil company. Furnish references. Box E-648, The Oil and Gas Journal, Tulsa, Oklahoma.

PRODUCTION man, twelve years experience, Drilling Completion, Workover, some secondary recovery. Now employed, desires change. Can give references, 37 years of age. Box E-671, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM ENGINEER with extensive water-flooding experience (reservoir studies, equipment selection, system design, well drilling, conversion, and remedial work, preparation of reports and cost estimates), desires change. Will consider foreign work. Box E-662, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOLOGIST, petroleum, 4 years experience, well watching, subsurface mapping, geological evaluations in Okla. and Tex. Presently employed as district geologist, large independent. Desires position with independent or small company on salary and interest basis. Box E-666, The Oil and Gas Journal, Tulsa, Okla.

THE RIGHT MAN: Can you fill the position you have open from the qualifications listed in this column? Men are always looking for an opportunity to improve themselves. Use a "Help Wanted" Journal classified advertisement to find the men you need. See box heading for classified rates or write The Oil and Gas Journal.

REAL ESTATE

JUST what you've been wanting for that Summer home, year-around retirement home, tourist court, dude ranch or model hotel. We have 40 acres adjoining beautiful Manitou Springs, Colorado. Just right for developing to suit yourself; not too rough or hilly, but just the right location for the most panoramic views, and with secluded valleys, stately pines and beautiful building stones. A real bargain at $18,000. G. W. McLaughlin, 3506 West Pikes Peak, Colorado Springs, Colo.

SPACE IS NEEDED: A Journal display classified advertisement is the quickest way to rent or sell your real estate. In the present period of expansion oil industry firms urgently need the space you have available. If it isn't listed here, you may also find it by stating your needs in these pages. For classified rates see box heading or write The Oil and Gas Journal.

FOR LEASE

OFFICE SPACE

OKLAHOMA CITY

Up to 50,000 sq. ft.

Main at Walker

air-conditioned

Fire proof

Inquire

SCHONWALD

718 N. Broadway

Oklahoma City

Phone Regent 6-5153

ROYALTIES

WE will buy producing or non-producing oil royalties. Standard Security Company, 111 Broadway, New York 6, N. Y.

MONTANA ROYALTIES
Millions of acres now leased by world's major companies, with huge drilling play in prospect. For booklet describing Montana geology and oil development, write Landowners Royalty Company, Box 1225, Great Falls, Montana.

GET TOGETHER: Both Capital and Royalties are available. If the investment proposition you want isn't listed in this column, use a Journal classified advertisement to find it. See box heading for classified rates, or write The Oil and Gas Journal.

LEASE AND DRILLING BLOCKS

2000 ACRES Wayne County, Illinois; hot spot of Illinois Basin. 100 to 500 acre blocks. Want drilling proposition. Prefer Cable Tool Rig capable of 3500 ft. Address P. O. Box #339, Mt. Vernon, Ill.

270 ACRES in Hogshooter Pool, Washington County, Oklahoma. Successful waterfloods nearby. Core on piece shows good flood recovery potential in Bartlesville Sand at 1100 feet. Will give 13/16 lease on coring option to party willing to develop. Box 230, Bartlesville, Oklahoma.

CAPITAL immediately available for geologically attractive Drilling Deals, Oil Producing Properties, Producing and Non-Producing Royalties. Send full particulars. Box E-622, The Oil and Gas Journal, Tulsa, Oklahoma

INVESTMENT funds wanted—From excess taxpayers by independent oil operator. For exploratory well drilling immediately. Geologically favorable. Illinois basin. Box E-569, The Oil and Gas Journal, Tulsa, Oklahoma.

OIL INVESTMENT Opportunity: Reputable oil operators in the Illinois and Indiana Basin propose and offer a unique investment opportunity. An exploratory program of ten wells is planned for 1952. These tests to be drilled in blocks with the best geological and geophysical background. Locations to be double checked by independent geologists. One Hundred Thousand Dollars will be required to carry out this program. We will back up the program with an investment on our part of not less than ten thousand dollars and up to twenty if necessary. Bank references furnished. If interested in such "Package" drilling deal and financially able to invest a minimum of five thousand dollars in this search for oil please write for further information. Box E-643, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED: Producing Oil Royalties and Overrides, Large or Small, Any County, Any State, pay you right off. Wire—Write—Call, Jack Eagle, 311 City Nat'l Bldg., Okla. City, Okla. Phone—REgent 6-7027.

LAND to lease for oil and gas, 2000 acres just east of the Iverson Well at Tioga for Lease. Box 35, Palermo, N. Dakota.

THE American Legion, Department of Texas, offers for lease to the highest bidder mineral rights southeast quarter, Section 31, Block A L and SV RR CO. Survey, Reag'n County, Texas. Submit bids to Ralph Holmen, chairman, board of trustees, the American Legion, Department of Texas, Suite B-1 Commodore Perry Building, Austin, Texas, on or before noon, Wednesday, April 23, 1952. Board of trustees reserves right to cancel all bids. Attest, G. Ward Moody, Adjutant.

WANTED: Some interested party to give us an 8000 foot test well in the future oil fields of the states of Oregon and Washington. Leases and drilling blocks now ready. A. H. Groneman, 5029 N.E. 13th, Portland 11, Oregon.

FOR a limited time NEW CAPITAL for operators or for purchase. If you have production and need new "easy term" working capital to refinance obligations, drill more wells, expand, or desire to sell, contact us for details. In reply don't give details—merely state size of lease, number producing wells, daily pipe line runs and whether prorated. Don't sacrifice before you contact us. Box E-624, The Oil and Gas Journal, Tulsa, Oklahoma.

LEASE AND DRILLING BLOCKS

BLOCK of Acreage in South Oklahoma near Red River on good structure, want it drilled. Write J. R. Riley, Box 506, Tishomingo, Oklahoma.

NEW MEXICO Oil and Gas Leases for sale. 2100 Acres, Chaves, Eddy, Roosevelt, Valencia Counties. Box E-651, The Oil and Gas Journal, Tulsa, Oklahoma.

WILL pay cash instantly for leases (large blocks), royalties, mineral deeds, production. Write fully—P. O. Box 2153, Denver, Colorado.

FOR SALE: Four oil and gas leases in shallow territory, two large leases excellent for water flooding, all in Allen County, Kentucky. Buel Wilson, Box 184, Scottsville, Ky.

WE invite inquiries from persons interested in Oil and Gas Leases in Southern Alberta, North Central Montana and the Williston Basin. Box E-664, The Oil and Gas Journal, Tulsa, Oklahoma.

2000 ACRE Block, Centers 19-13N-19E Muskogee County, Oklahoma; lays on high side. 600 feet, Keefeton fault; 3 Dutcher Sands, Wilcox. Completed well, First Dutcher, 650 feet, 280,000 Cubic feet, ready for market. Immediate sale, Phone 1258, Seminole, Oklahoma.

HAVE 400 acres oil lease that will produce shallow oil. Viola lime 1520 ft., Wilcox 2570 ft. Will turn for 1/16 override. SEC. 8-2S-8E. W. J. Rogers, Connerville, Okla.

LOOKING FOR A LEASE? There will be over 40,000 wells drilled this year. If you are looking for a lease, drilling block, or drilling deal and haven't found it in this column, or if you have a lease or drilling block you want drilled, a Journal classified advertisement can find an interested party. See box heading for classified rates, or write The Oil and Gas Journal.

FOR SALE
OIL BONUS

Under Major oil company's very large, well located lease. For information write

Box E-655, The Oil and Gas Journal, Tulsa, Oklahoma

LEASES ROYALTIES

Producing and Nonproducing
Bought and Sold—Any Area
Inquiries Invited

B. D. BUCKLEY
6635 Delmar Ave., St. Louis 5, Mo.

WANTED TO BUY

real oil production from owners only. Won't assume overriding royalty. Please quote net price. Principals only.

Box E-670, The Oil and Gas Journal, P. O. Box 1260, Tulsa, Okla.

GET IN ON A "MAJOR" PLAY!

Major Oil Companies and a large number of progressive independents are making a great lease play in certain areas of Western Kansas, and we have some well located leases and royalties right in with and under the big company spreads. Here is the small man's chance to be in on the ground floor of a 'big company' play. Write us for full details.

ACACIA OIL & ROYALTY CO.
1365 East 52nd Place,
Tulsa, Oklahoma

MANUFACTURERS REPRESENTATIVE

LONG established small but effective organization in California oil industry desires additional line of equipment preferably in engine or other machinery field. Can function as manufacturer's representatives or dealers. Box E-598, The Oil and Gas Journal, Tulsa, Oklahoma.

LEGAL BLANKS

BURKHART LEGAL BLANKS since 1908. Oil-Gas (all states), Business, Real Estate, Legal Forms, Leases, Revised With Government Regulations, Commercial Printing. Catalog and Samples on request. Burkhart Printing & Stationery Company, 115 South Cincinnati, Tulsa, Oklahoma.

BUSINESS OPPORTUNITIES

Experienced Consulting Geologist and engineer thoroughly familiar with Oklahoma oil prospects and with the ability to handle leasing, drilling, development and operation of oil properties, desires connection with an individual or group of individuals who will finance a drilling program. Will operate on an interest plus a retainer. Can get results. **Box E-644, The Oil and Gas Journal, Tulsa, Oklahoma.**

Central Area

(Continued from page 387)

2,000,000 cu. ft. and mercury was blown from the tube. It was estimated that gas was showing in excess of 3,000,000 cu. ft. a day on this drill-stem test.

First test of the Traverse section in the Mineral Springs Stray gas and Dundee oil pool was tested out dry this week at Mogul Oil Co. 6 Hammer, SW SW NW 21-20n-9w, Sherman Township, Osceola County. Traverse lime was logged at 3,244 ft. and section was cored to 3,256 ft. Porosity showed in core from 3,251-54 ft. and on drill-stem test run for 25 minutes, 50 ft. of drilling mud, no oil or gas was recovered. Dundee objective was scheduled to be under test within 5 days.

ILLINOIS WILDCAT FAILURES

Bond County: Doran 1 Gaffner, NE SW NW 20-4n-3w, dry, TD 1,241 ft.
Clark County: C. M. Faulker 1 Miller, SW NE SW 25-12n-13w, dry, TD 700 ft.
Cumberland County: Continental Oil Co. 1 Sharp, SE NW SE 13-9n-10e, dry, TD 1,585 ft.
Edwards County: Magnolia Petroleum Co. 1 Ulm, NE SE NW 17-1n-14w, dry, TD 3,191 ft.
National Associated Petroleum Co. 1 Allison, SE SW NW 8-3s-14w, dry, TD 3,194 ft.
Effingham County: Ted Lindsay 1 Horath, SW SW NW 2-6n-6e, dry, TD 2,775 ft.
Franklin County: National Associated Petroleum Co. 1 Lipe, SW NW NW 29-6s-1e, dry, TD 2,926 ft.
Hamilton County: Stanford Oil Co. 1 Roy, NE NW SW 20-5s-6w, dry, TD 3,491 ft.
Randolph County: Don Baines 1 Robinson heirs, SW NW SE 29-4s-5w, dry, TD 2,293 ft.
Sangamon County: Cliff Perardi 1 Morris, NE SW NW 3-15n-3w, dry, TD 790 ft.
Shelby County: Alfred Branyon et al 1 Van Syckel, SE SW NW NE 30-1n-2e, dry, TD 2,515 ft.

INDIANA WILDCAT FAILURES

Daviess County: Joe Reznik 1 Arvin-Clements Graber, SE SW NW 34-3n-6w, dry, TD 2,175 ft.
Gibson County: Morris Drilling Co. 1 Bingham, SW NE SW 8-1s-11w, dry, TD 2,118 ft.
Inland Producers 1 Boren, NE NW NE 18-4s-11w, dry, TD 2,612 ft.
Monroe County: Jone Development Co. 1 Snapp, SE SE SE 28-7n-2w, dry, TD 2,178 ft.
Sullivan County: F. B. Cline 1 Sluder, SW NW SW 18-9n-9w, dry, TD 1,006 ft.

WESTERN KENTUCKY SUCCESSFUL WILDCAT

Webster County: The Texas Co. 1 Royster, EL NW SW NE 6-N-24, IP 11 bbl., Benoist 2,314-28 ft., TD 2,355 ft. (extension Poole field).

WESTERN KENTUCKY WILDCAT FAILURE

Webster County: Delta Drilling Co. 2 Westerman, S½ NE NW SW 24-N-23, dry, TD 2,735 ft.

MICHIGAN WILDCAT FAILURES

Allegan County, Martin Township: F. W. Kehlet, Trustee, 1 Honeysett & Consumers Power Co., SW SW NW 30-2n-11w, Traverse 1,629 ft., dry, TD 1,647 ft.
Watson Township: C. J. Trace 1 Paige, SE SW SE 13-2n-12w, Traverse 1,647 ft., dry, TD 1,651 ft.
Arenac County, Deep River Township: J. E. Bauer 1 Lubas, SW NE NW 28-19n-4e, Dundee 2,763 ft., dry, TD 2,932 ft.
Lake County, Newkirk Township: Louis Rose 1 Richardson, NE NE NE 14-19n-12w, Dunree 3,202 ft., Reed City zone 3,381 ft., dry, TD 3,394 ft.
Montcalm County, Day Township: McClure Oil Co. 1 Linton, NW NW NE 34-11n-6w, Traverse 2,953 ft., dry, TD 3,068 ft.

Oklahoma Fields

(Continued from page 385)

OKLAHOMA WILDCAT FAILURES

Beckham County: Flynn Oil Co. 2 State Taylor, NE SW SW 31-9n-21w, dry, TD 3,045 ft.
Carter County: Harper-Turner 1 Nolan, NE NE NW 18-3s-2e, dry, TD 2,667 ft.
H. C. Wickham et al 1 Brady NW NW SE NW 17-1s-2w, dry, TD 2,492 ft.
Warren Shear 1 Mullen, NE NE SW 7-1s-2w, dry, TD 3,309 ft.
Cleveland County: Glen Smith 1 Stipes, SW SW NE 26-7n-1e, dry, TD 6,586 ft.
Cotton County: S. F. Hutcheson 1 C. T. Thomas, C NE SE 36-1s-12w, dry, TD 2,319 ft.
Grant County: The Texas Co. 1 Clive, SE SE NW 28-27n-6w, dry, TD 5,799 ft.
Jackson County: Weller Bush Corp. 1 Gore, SE SE SE 13-1s-12w, dry, TD 2,319 ft.
Lincoln County: W. O. Allen et al 1 Fowler, SE SE NW 25-12n-4e, dry, TD 4,509 ft.
Harper-Turner 1 Cansler, NE NE SW 17-13n-4e, dry, TD 4,583 ft.
C. C. and J. Marshall Nye 1 Richardson, NW NW NW 23-13n-4e, dry, TD 5,193 ft.
McElreath & Harvey 1 Klabzuba, SE NE SW 11-15n-3e, dry, TD 5,095 ft.
McClain County: Harper-Turner 1 Johnston, NE NE NE 33-5n-3e, dry, TD 3,136 ft.
Max Pray et al 1 Goddard, NW NE NE 35-5n-2w, dry, TD 8,359 ft.
McIntosh County: Pauley 1 Bennett, SE NE 18-10n-18e, dry, TD 4,461 ft.
Okfuskee County: Wood Oil & Gas Co. 1 Parks, NE NE SE 7-12n-8e, dry, TD 4,528 ft.
Oklahoma County: Mohawk Drilling Co. 1 Dunlap, NW NW NE 1-12n-1e, dry, TD 5,928 ft.
Payne County: T. N. Berry & Co. 1 Wright, C SE NE 8-17n-3e, dry, TD 4,316 ft.
Pottawatomie County: Sun Oil Co. 1 School Land "A", NE NE SW 16-11n-5e, dry, TD 4,928 ft.

Spencer-Safford Adds Benson to Engineering Staff

William C. Benson has been named to the engineering staff of Spencer-Safford Loadcraft, Inc., as production engineer, according to E. S. Safford, president.

Benson was stationed in Lufkin, Tex., with Lufkin Foundries & Machine Co., until 1944. While at Lufkin, Benson was indoctrinated into truck-trailer engineering and design. He was with American Body & Trailer Corp. in Oklahoma City, where he served as chief engineer from 1949-1952, prior to joining Spencer-Safford.

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REGISTER and VOTE — it's YOUR country

"You may have to stand outside!"

REMEMBER Aesop's fable of the camel and his master--how the kind master allowed the shivering beast to put into the tent first his head, next his shoulders, then his forelegs!

And then the camel said, "Master, I think I ought to come wholly inside," and crowded in. Immediately he said, "There is hardly room for us both, so I think it would be better for you to stand outside so I can turn around and lie down." And without further ado, the camel kicked the man out and took the entire tent.

Men have heard this story for 2,500 years--repeatedly have seen how it illustrates what happens when one man or group of men gain power over others. Men saw it happen in Italy and Germany when Mussolini and Hitler took over. Men saw it happen in Russia.

Even here in America a similar trend is evident. Powerful influences overlook no opportunity, through political manipulation, central controls and bureaucratic regulations, to intrude more and more in our private lives. The situation demands continual, alert watchfulness by all citizens who believe in individual liberty and freedom, to prevent this camel of big government from creeping further into the tent. Before we realize it, "we, the people," the master, may find ourselves "standing outside." In America it is government, which is the servant of the people.

YOUR SCRAP IS NEEDED — YOUNGSTOWN

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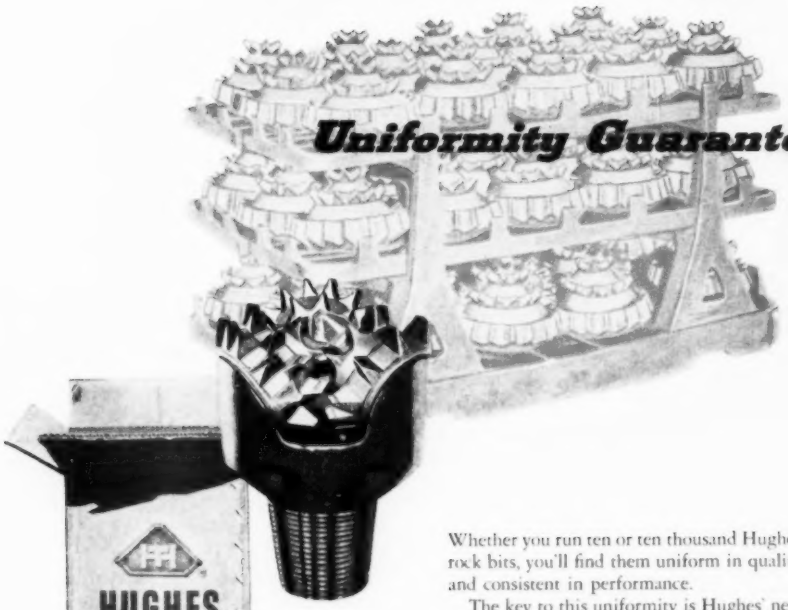
MANUFACTURERS OF CARBON ALLOY AND YOLOY STEELS

The steel industry is using all its resources to produce more steel, but it needs your help and needs it now. Turn in your scrap, through your regular sources, at the earliest possible moment.

Uniformity Guaranteed!



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Whether you run ten or ten thousand Hughes rock bits, you'll find them uniform in quality and consistent in performance.

The key to this uniformity is Hughes' new method of carburizing and heat treating, employing new automatically controlled equipment and a metallurgical experience gained in 43 years of manufacturing rock bits.*

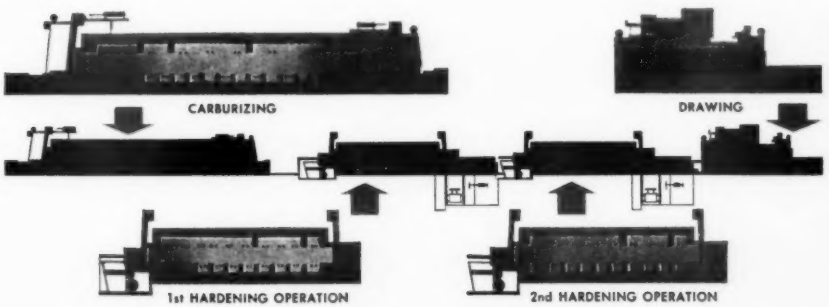
Since 1945, three heat treating furnace lines have been installed. The hardening furnaces in these lines, together with their discharge chambers for quenching, are sealed so that atmosphere as well as temperatures can be controlled.

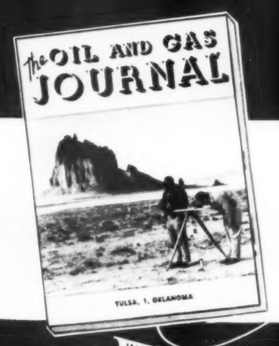
These new furnace lines permit the desired level of carburization to be set and maintained without variance. The metallurgical characteristics of the case best suited to each size and type of bit is thus assured.

Heat treating—the refining, hardening and drawing of the steel—is done in three stages, each a continuous, automatic operation, in which every step is time-controlled.

Carburizing and heat treating as now done by Hughes, with the latest, most modern equipment available, is your guarantee that the rock bits you get will give the uniform, dependable performance for which they are designed.

*Hughes Tool Company is the largest deep case carburizer of manufactured products in the world.





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LEGEND

Sedimentary Basins

Deepest Part of Basin

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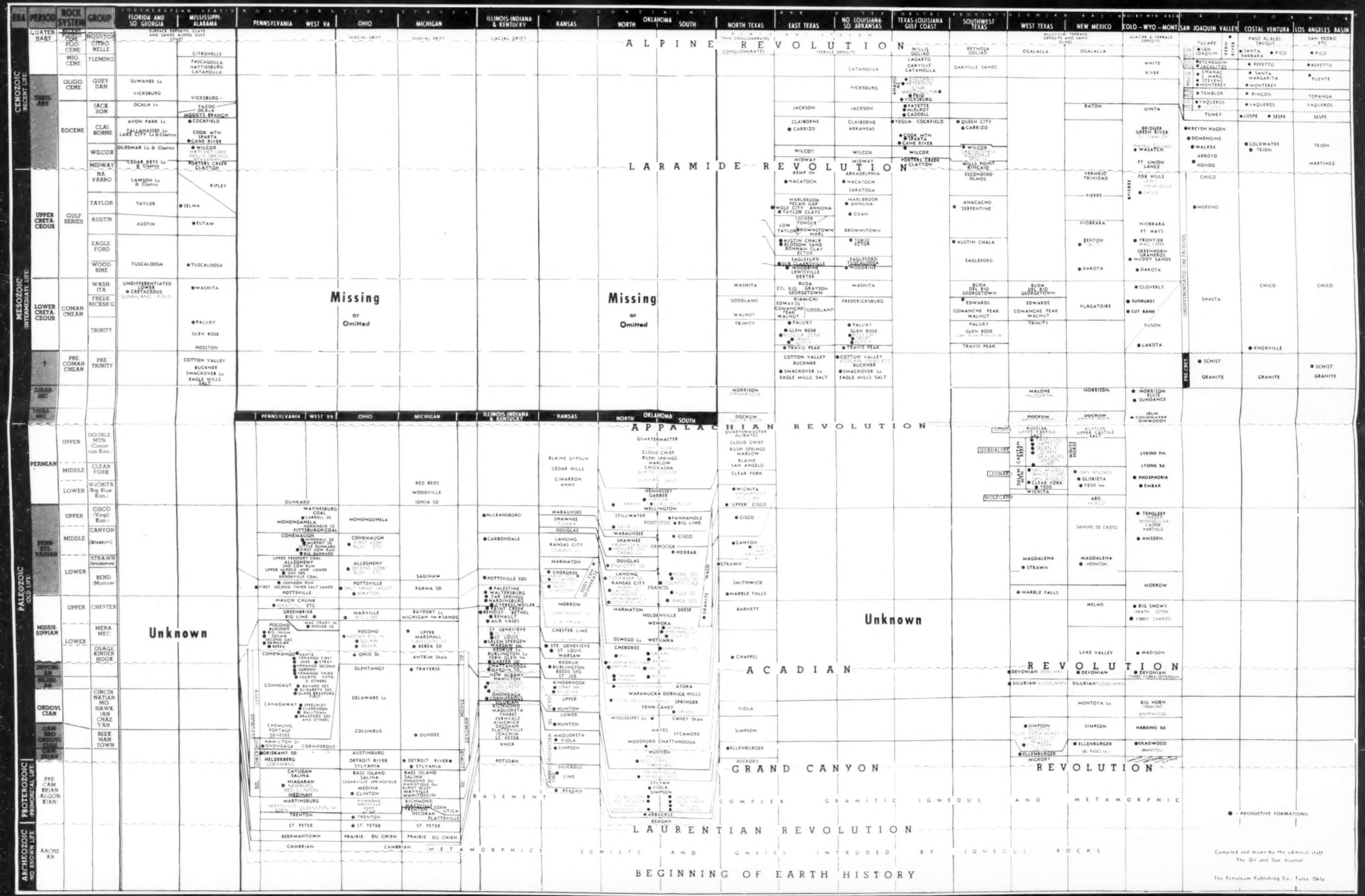

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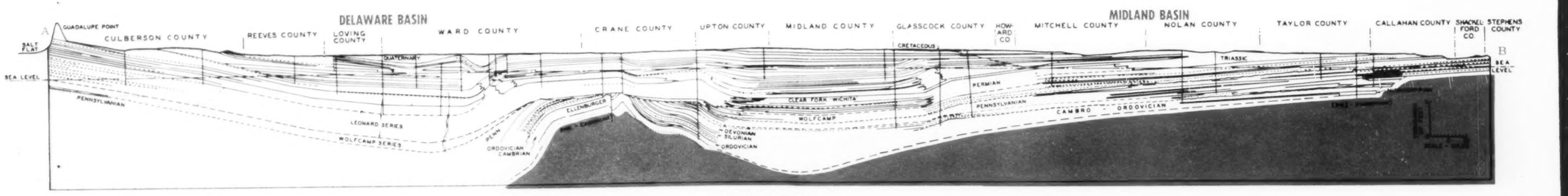

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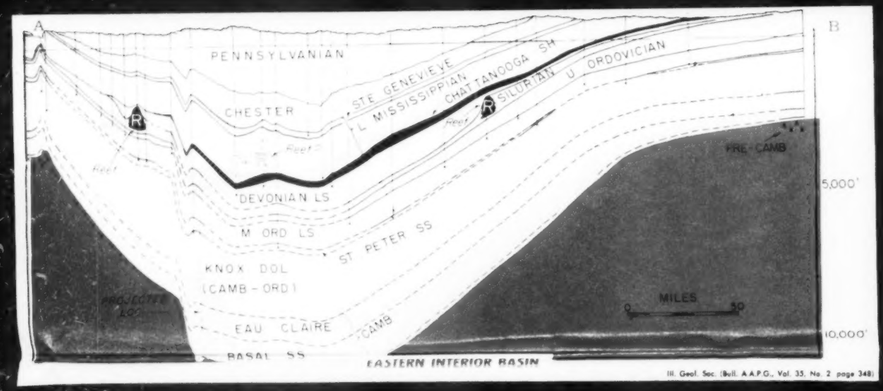

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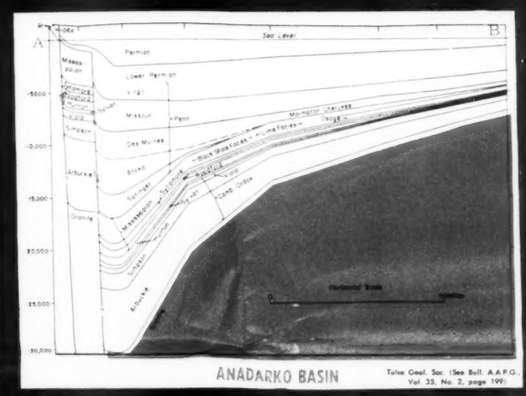

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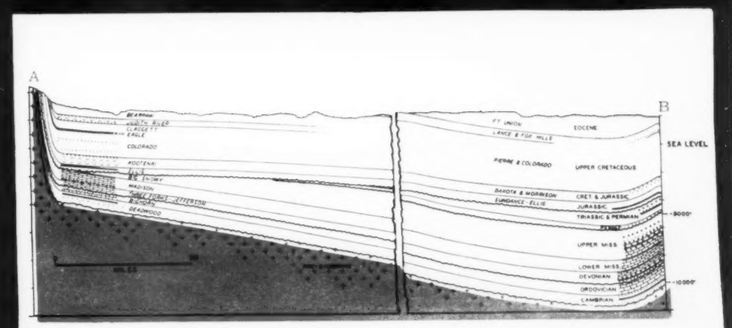

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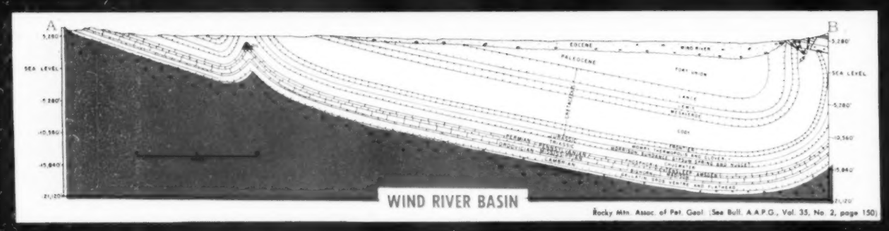

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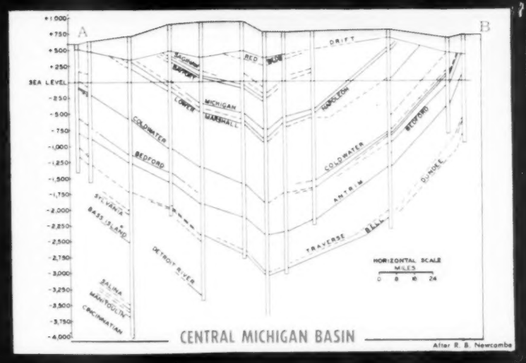

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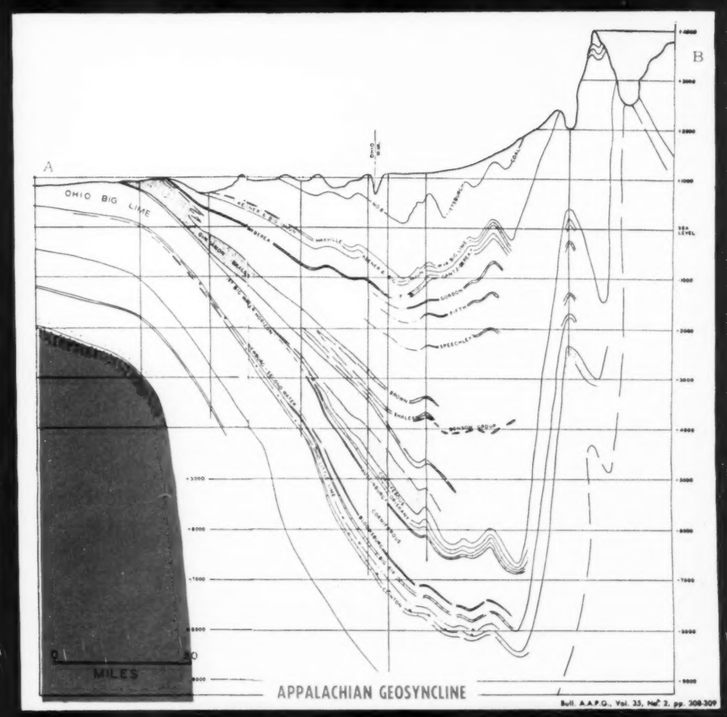

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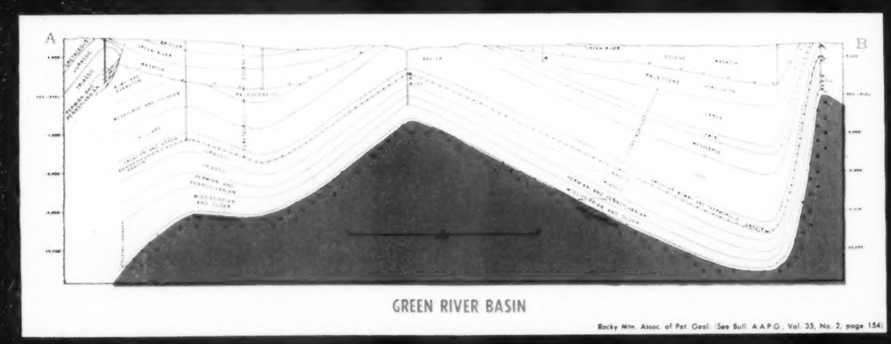

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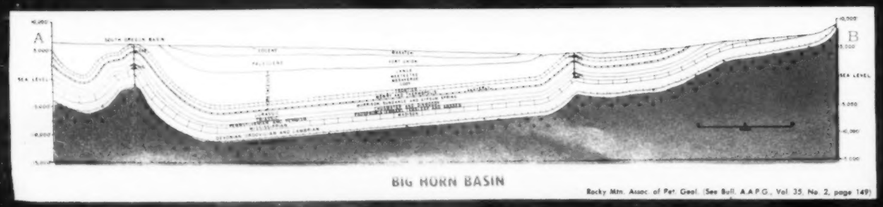

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BLACK MESA BASIN

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BIG HORN BASIN

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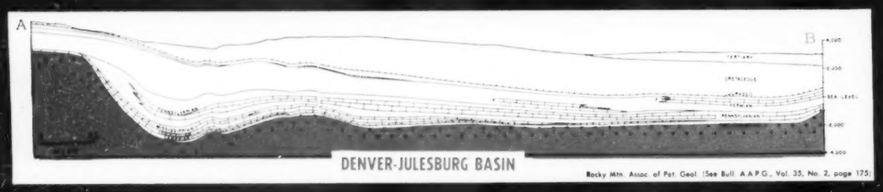
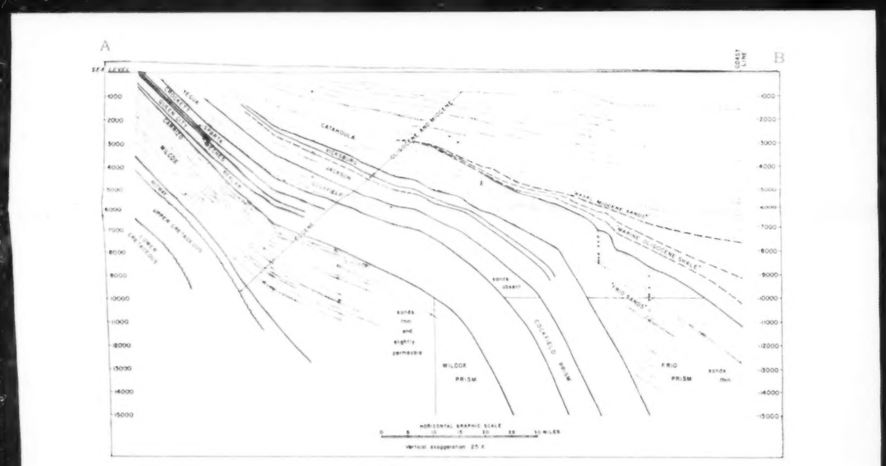


DENVER-JULESBURG BASIN

Rocky Mtn. Assoc. of Pet. Geol. (See Bull. A.A.P.G., Vol. 35, No. 2, page 175)

SACRAMENTO VALLEY

H. D. Hobson, Bull. A.A.P.G. (Vol. 35, No. 2, page 72)

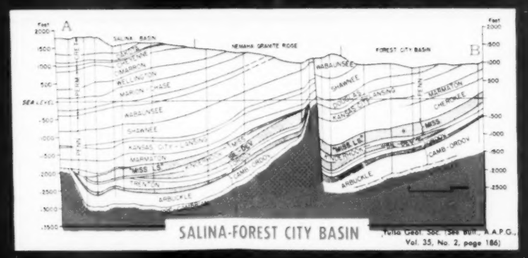


WESTERN GULF EMBAYMENT

Houston Geol. Soc. (See Bull. A.A.P.G., Vol. 35, No. 2, page 247)

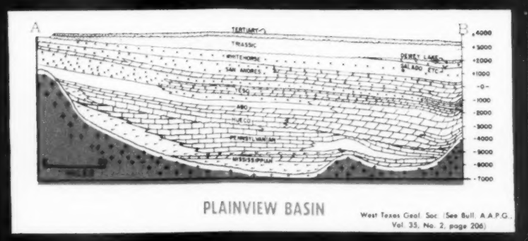
BLACK MESA BASIN

Rocky Mtn. Assoc. of Pet. Geol. (See Bull. A.A.P.G., Vol. 23, No. 8, page 71)



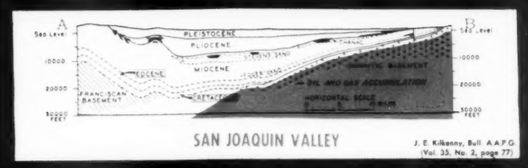
SALINA-FOREST CITY BASIN

Tulsa Geol. Soc. (See Bull. A.A.P.G., Vol. 35, No. 2, page 186)



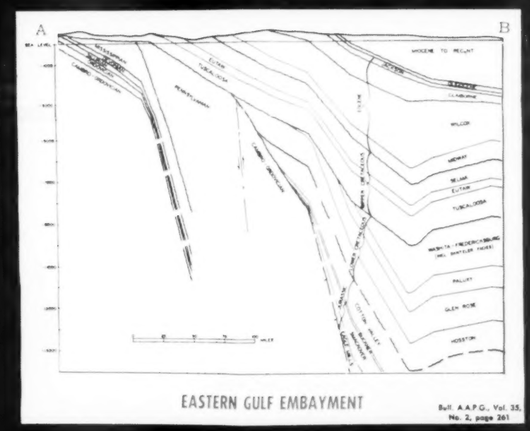
PLAINVIEW BASIN

West Texas Geol. Soc. (See Bull. A.A.P.G. Vol. 35, No. 2, page 206)



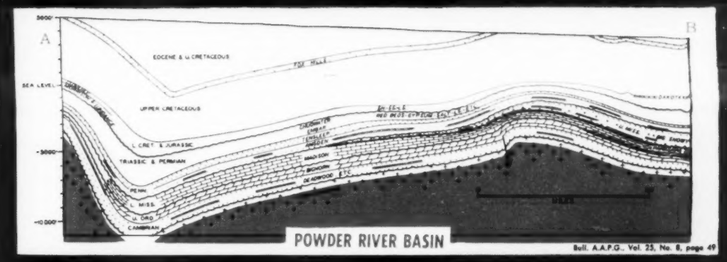
SAN JOAQUIN VALLEY

J. E. Kilkenny, Bull. A.A.P.G. (Vol. 35, No. 2, page 77)



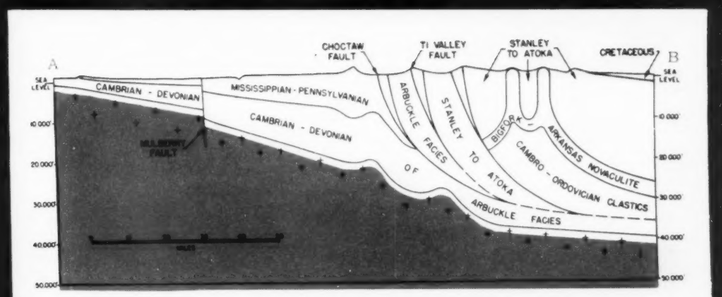
EASTERN GULF EMBAYMENT

Bull. A.A.P.G., Vol. 35, No. 2, page 261



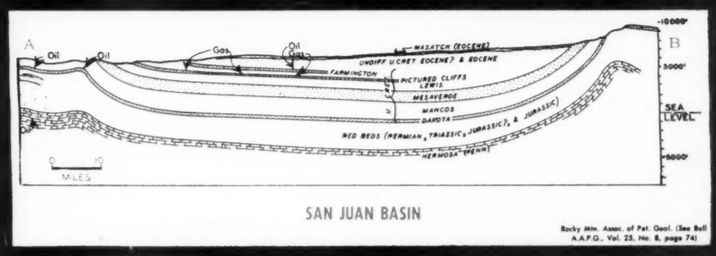
POWDER RIVER BASIN

Bull. A.A.P.G., Vol. 23, No. 8, page 49



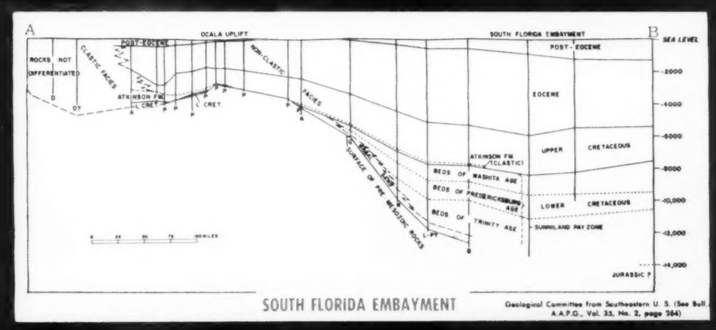
McALESTER BASIN

Tulsa Geol. Soc. (See Bull. A.A.P.G., Vol. 35, No. 2, page 193)



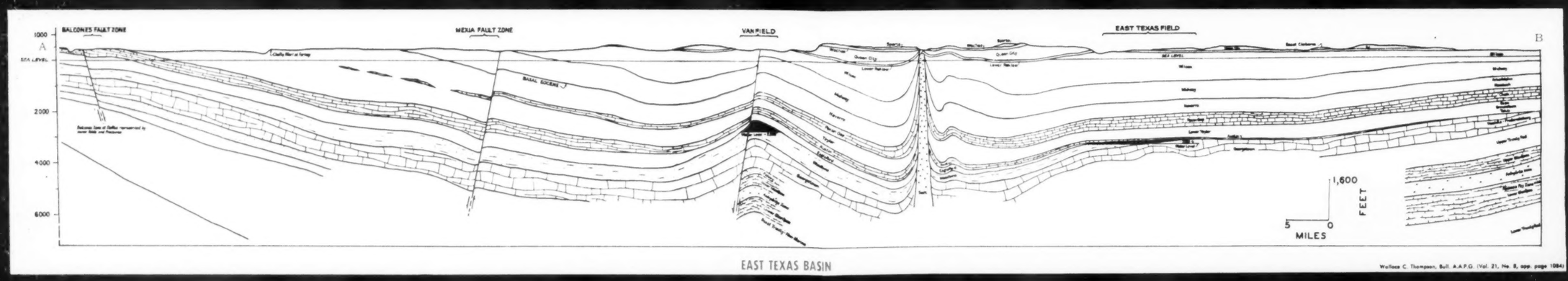
SAN JUAN BASIN

Rocky Mtn. Assoc. of Pet. Geol. (See Bull. A.A.P.G., Vol. 23, No. 8, page 74)



SOUTH FLORIDA EMBAYMENT

Geological Committee from Southeastern U. S. (See Bull. A.A.P.G., Vol. 35, No. 2, page 384)



EAST TEXAS BASIN

Wallace C. Thompson, Bull. A.A.P.G. (Vol. 21, No. 8, app. page 1084)